Summer

Undergraduate

Research

Fellowships



1989 Annual Report

California Institute of Technology

The passing on of ideas and style to the next generation is the most lasting and gratifying raison d²etre of a university.

Hans Liepmann SURF Kickoff dinner, 1989.

For the fifth consecutive year, a generous gift from AMETEK, Inc., has been used to offset production costs of publishing the SURF Annual Report. We are deeply grateful to Caltech alumni Robert L. Noland (BS41ME), President, and Alfred Schaff (BS41ME), Assistant to the President, for their personal support as expressed through AMETEK.

Dedication



The SURF program in 1989 is dedicated to Dr. Hans W. Liepmann, Theodore von Kármán Professor of Aeronautics, Emeritus. A member of the faculty since 1939, his long involvement in the welfare of undergraduates has helped many to successful careers in academia, industry and the military. Dr. Liepmann's research in fluid mechanics, his pursuit of excellence, and his communication of this drive to students, have contributed immeasurably to the quality of education at Caltech.

Contents

President's Message

Tresident's message	4
SURF Board Chairman's Message	3
Administrative Committee Chairman's Message	4
"Caltech Survival"	5
History of SURF	8
1989 in Review	0
Abstracts1	6
Biology	6
Chemistry and Chemical Engineering2	0
Engineering and Applied Science2	4
Geological and Planetary Sciences2	9
Humanities and Social Sciences	0
Physics, Mathematics and Astronomy	2
Computation and Neural Systems	6
JPL	8
Off Campus	4
SURF Publications	6
Index of Students and Sponsors5	1
1989 SURF Donors	7

President's Message



This year we must say goodbye to Fred Shair, chairman of the SURF Administrative Committee and professor of chemical engineering. He is leaving SURF and Caltech to become Dean of Natural Sciences at the California State University at Long Beach. We thank him for all of his efforts; the SURF program would not be here today were it not for his diligence, enthusiasm, and unflagging support.

As a member of the faculty's Scholarships and Financial Aid Committee, Dr. Shair was SURF's creator eleven years ago, and has been its guiding light ever since. He coined the acronym SURF. His direction carried the SURF program through its early years. He brought together a dedicated team, laying the groundwork for the phenomenal growth and success of the program.

The first year, 18 students and 17 faculty members participated in SURF. Under Dr. Shair's direction, the number of students participating has grown every year. The sponsors have expanded to include not only Caltech faculty, but also JPL technical staff, faculty at other universities, and corporations.

With Samuel Krown, Dr. Shair helped to set up the SURF Board to ensure continued annual funding of the program. Dr. Shair has worked extensively with these donors, and developed close friendships with many of them.

Three years ago, Dr. Shair became one of the charter members of the governing board of the National Conference on Undergraduate Research. His descriptions of Caltech's SURF program have helped other universities establish similar programs.

Through Dr. Shair's efforts, undergraduates who successfully complete their SURFs may be nominated and elected to Sigma Xi, the National Research Society.

More than 1050 Caltech undergrads have SURFed during the program's eleven summers. They join us in thanking Dr. Shair for his vision, commitment, leadership, and support.

As the Caltech SURF program enters its second decade, it continues to grow in popularity and prestige. With more undergraduates participating than ever before, 188 this summer, the SURF ranks have been broadened to include 31 non-Caltech students from across the country and even one from China. The Institute owes a special tribute to Fred Shair's outstanding leadership, the selfless dedication of so many SURF faculty sponsors, and the program's special friends, whose generous gifts make SURFing possible at Caltech. SURF always reflects well on its parent institution, which also endeavors to excel at everything it sets out to do.

Thomas E. Everhart President California Institute of Technology

SURF Board Chairman's Message



On behalf of the SURF Board, I give a hearty congratulations to all of the students who completed research projects this summer and their sponsors. We deeply appreciate the support of the individuals, corporations, and foundations who, through their gifts to Caltech and to the SURF program, have made the SURF experience possible for the 188 select and self-motivated undergraduate students who participated this summer.

Private gifts continue to contribute substantially to the vitality of SURF. Individual giving has improved, and privately-funded, named SURF endowments have grown. With the strong support of President Everhart, Vice President for Institute Relations Theodore P. Hurwitz, other members of Caltech's administration, and the splendid SURF staff, we were able to finish this year in the black, with even a slight surplus which will enable us to hit the ground running—or more appropriately, hit the beach SURFing—next year.

As I complete my two-year term as chairman, I feel a warm sense of personal gratitude for the opportunity to have served the Board with all the good friends of SURF in this extraordinary and innovative program. As I hand the gavel to Arthur Adams, I do so with every confidence in his ability to lead us toward even greater SURF years, and I pledge to work closely with him to achieve our goals and to meet the challenges ahead.

Challenges are never ending and almost always unpredictable. As the year drew to an end, we learned that Professor Shair, founder and director of SURF since 1979, will be leaving Caltech to continue his academic career at California State University, Long Beach. Dr. Shair's vision, wisdom, and inspirational leadership have guided SURF from its beginnings. All of us will miss him. In recognition of his outstanding service to SURF, and our close personal relationships with him, the members of the Board have established the Professor Fredrick Harold Shair SURF Endowment, the income from which will support a top student each year in perpetuity. Good luck, good SURFing, and warmest best wishes, Fred!

Hugh F. Colvin Chairman, SURF Board Administrative Committee Chairman's Message



I am delighted to have the opportunity to work more closely with the SURF program—with the students, research sponsors, and the SURF Board. The program has achieved much in its 11 years under the enthusiastic and committed guidance of Fred Shair. As the new chairman of the SURF Administrative Committee, I am looking forward to continuing the development of new research opportunities for Caltech's undergraduates at the campus, at JPL, and beyond. I join with the other members of the Administrative Committee in wishing Fred good luck, stimulating challenges, and many opportunities for continued professional growth.

Terry Cole Chief Technologist, JPL Chairman, SURF Administrative Committee

"Caltech Survival"

by Hans Liepmann from his speech at the 1989 SURF Kickoff Dinner

> I am very touched and honored indeed at having this year's SURF program dedicated to me. Whatever contributions I made to the undergraduates at Caltech were only things I enjoyed, such as teaching, and were, at least according to Victorian standards, not very praiseworthy, and possibly sinful.

> I have made the title of my address deliberately double valued: Survival *at* and *of* Caltech: survival as a student (or possibly even as a faculty member) in the well-known pressure cooker on the one side, and the life expectancy of the pressure cooker itself as a unique institution on the other. To me these two are closely related, and any weakening of one impairs the other. Both depend heavily on a comradeship of faculty and students of which SURF is obviously an important ingredient.

My interest or even preoccupation with this survival issue is plain: Nearly my whole professional life has been centered about Caltech, surviving on the faculty, and being deeply interested in the survival of the type of institution from which I resisted leaving-fortunately, resisting pull, and not push!

The struggles for survival as a student I have experienced through the occasional howls of three of my own children who graduated from this same outfit, and from the more lasting experience of teaching, in particular teaching undergraduates. So the *necessary* conditions for talking about this subject are satisfied. However, as all of you have learned, or should have learned in Math 1, you need *sufficient* conditions as well, and of course even with all my experience, I may well have learned the wrong lessons or by now forgotten the correct ones. This decision I must leave to you. In any case, I have lasted on the faculty through the tenure of all of our presidents and all of our provosts and still find myself quite emotionally attached to the place. Imitating the television networks, I hasten to state that the opinions expressed here are my own and do not necessarily reflect the ideas of the organization sponsoring the event!

It may be useful to begin by quoting from R. A. Millikan's Autobiography, his statements concerning what Caltech is not:

It is not an orthodox university, since it does not seek, nor permit, great numbers of students, and since it does not embrace, nor wish to embrace, within its activities all the fields of human knowledge. If it did either of these two things it would lose its distinctive opportunity.

It is not an orthodox college, since it does not concern itself primarily with the field of collegiate education. If its foundation had added but one more to the seven hundred American institutions of the college type it is altogether obvious that there would be no justification for anyone calling it a particular significant research and educational enterprise. It is not simply a technical school, since it is striving to do what no technical school has even yet attempted, namely, to build up on one foundation a great center of creative activity in both pure and applied science, and to turn out engineers with such a cultural background as engineering schools have in general never been able to impart.

Certainly times have changed since these three Millikan "commandments" were stated and followed. (Knowing the many wisecracks about Millikan, I feel sure that somebody or other will remark that the old man must have been in a singularly humble mood to restrict his "commandments" to just three.) While it is easy to quibble with some of the language and some of the assumptions, I think that the survival problems both *at* and *of* Caltech are rather closely related to the difficulty in living up to the standards implied by these "commandments." They require a very unusual student body and an equally unusual faculty, capable of making full use of the opportunities offered by the small size of the institution, and willing and able to live within the constraints it imposes.

I have always thought of Caltech as providing a unique experience for undergraduates who are so intensely interested in science and technology that broad cultural and social interests are often secondary and postponed, with a faculty more a fraternity of scholars than an assembly of administrators and employees. It is certainly not easy to preserve such an unusual institution in the present climate of ever-increasing red tape and competition for government contracts, let alone fear of lawsuits for real or imaginary slights. Indeed, the very distinct and special character of Caltech is really very fragile and can be rather easily lost by following fashionable avenues often supported by, internally or externally, wellmeaning activists with more brilliance than wisdom.

How does one find the appropriate inmates?

Clearly it is not possible to devise a system which will invariably find and protect a new Ramanujan or Galois, but if one school could be capable of at least accommodating and nurturing gifted oddballs, it should be Caltech with its small size and (hopefully) with the resulting flexibility! In a time when conformity becomes ever more prevalent, we certainly need these human singularities, and what better place can be found for their schooling than at Caltech. After all, we are trying to select a team, elitist and competitive like the Forty-Niners, but geared to getting on the Rose Bowl scoreboard from a mile away by remote control rather than from on the field. Not every gifted student will shine in class work either. Here, I believe, SURF again plays a very important role in providing the opportunity to apply, develop, and demonstrate dormant abilities which are not classroom adaptable.

Unusually bright kids have their problems. Of course it is traumatic for the single leading light of a high school class to adjust to being surrounded by many leading lights among his classmates, and being less shining than some. I will never forget the face of one undergraduate who complained to me about this very trauma, when I responded with the question of how he thought I felt being on the same faculty with Dick Feynman!

In spite of all the complaints about student life, a low-key but very successful student self-government exists, as well as an almost uniquely effective honor system. I remember that the latter was commented upon, with surprise and even awe, in the so-called *Underground Guide to the Colleges*, a typical publication of the sixties.

Close faculty-student relations should be no problem with our high faculty-to-student ratio, but this essential familiarity has, I believe, deteriorated. One problem here is evidently the difference in the distribution of students and faculty over the divisions and options. The characteristic time for changes in the faculty is evidently much longer than for the student body and consequently one cannot and should not expect to find a precise match. But we could do better. Other obvious reasons for the increasing isolation of students from faculty is the far greater involvement of faculty in the ever-increasing red tape of research proposals and contracts and the (unfortunately) increasing number of problem sets for students. The former is certainly a nationwide problem and likely to get even worse. The latter could, I am convinced, be vastly improved, without impinging on the quality of instruction.

We can, I believe, do even more on the local level to improve greater intimacy: Promoting faculty-student social gatherings, such as joint parties in the Athenaeum, at more or less regular intervals; the faculty meeting with one of the houses at a time seems feasible to me, in addition to the current invitations to faculty members for meals in the houses. Strengthening SURF is obviously one successful way to accomplish one, hopefully minor, caveat: Not to use SURF as a vehicle to provide cheap help for research contracts.

But to me, the single most important item is an active dedication to improve undergraduate teaching. I fully understand the intensity, the almost hypnotic attraction of working on a fascinating unsolved problem and the overwhelming ecstasy of original discoveries in research. The immersion in creative research is certainly one of the essentials of life at Caltech, and its experience is crucial for the other essential—creative teaching.

The older you get, the more you realize that passing on ideas and style to the next generation is the most lasting and the most gratifying final result and raison d'etre of universities. For this transfer, SURF provides a unique bridge between faculty and undergraduates, and I wish it all possible success for 1989 and beyond. Even the original founders of SURF had no idea of the phenomenal success the program was going to be. Founded in 1979 with 18 students and 17 faculty sponsors, the Summer Undergraduate Research Fellowships program has served over a thousand students and has been the model for similar programs at universities throughout the country.

Caltech has long had a history of supporting undergraduate research. After his arrival in 1920, Arthur A. Noyes initiated a program of chemical research for undergrads at Caltech's marine biology facility in Corona del Mar. This program dissolved in the mid-thirties, but Caltech learned that undergraduate research was highly desirable and needed institution-wide involvement and assured financial support.

The SURF program was designed in 1979 by the faculty's Scholarships and Financial Aid Committee. Faced with the need to distribute monies from the President's Prize Fund to undergraduates on a merit basis, and with the fact that the National Science Foundation was phasing out its undergraduate research program, Professors Fred Shair and Hal Zirin developed the proposal from which SURF was created. The committee endorsed the idea of undergraduate-faculty research projects. Not only would it reward meritorious achievement, but it would create new opportunities for the students' professional growth.

The ten-week program was designed to contain all the elements of a professional research project. Each applicant collaborates with a research sponsor to define and develop the project, and writes a proposal for funding. This proposal, as well as faculty recommendations, are reviewed by the SURF Administrative Committee. Once funded, the student carries out the research with coaching from his or her sponsor. The results are presented at SURF Seminar Day, a proceeding based on professional, technical meetings.

The wisdom of these original guidelines is clearly evident today: the founders of the program anticipated that, someday, 80 students would SURF; this year over double that number participated.

Through the SURF program, students have discovered, many for the first time, how exciting front-line research can be. They gain insight into what a professor's professional life is like, and about the kind of career they might like to pursue in the future. Equally important is the interaction between students and professors that the SURF program provides. Research sponsors are more than qualified teachers for undergraduate researchers; they are mentors. The mentor-protege relationship encompasses not only the research project but also the relationships within the research group, the economics of research, and the general climate of the department or the institution. This student-sponsor relationship is one of the most important aspects of the SURF experience.

In addition, sponsors provide space, equipment, laboratory supplies, computing time, and occasionally, travel expenses.

The SURF Administrative Committee, formed in 1984, sets the general policy for SURF. The goals of the committee are to fund every student with whom a member of the faculty or JPL technical staff enthusiastically wants to work. Proposals and letters of recommendation are reviewed by the committee and are rated outstanding, excellent, good, or weak. The committee's goal is to fund every outstanding and excellent proposal. The committee also provides the administration with advice on long-term planning, financial development, and outreach programs involving emeritus professors,

admissions, alumni, donors, JPL, and other institutions.

Supplemental programs such as noontime research seminars; leadership roundtables led by industrial, government and academic leaders; and communications workshops have enhanced the SURF program in recent years.

The continued support of many generous donors has made this increase in the program and in student participants possible. Samuel P. Krown, SURF's initial financial supporter, generously lent his leadership in the critical early stages of the program. Additional thanks are due Samuel and Frances Krown who established the first SURF endowment as a major step toward achieving continued funding.

Mr. Krown helped to form the SURF Board, an organization of individuals and corporate and foundation representatives who are dedicated to the value of undergraduate research at Caltech. The Board, through their volunteer efforts, advice, encouragement, and financial support, contributes greatly to the effectiveness of the SURF program. We thank the past chairmen of the Board: Samuel Krown, Betty Nickerson, and Hugh Colvin, who concluded his term on SURF Seminar Day, for all their efforts.

Each year since 1985, the SURF program has been dedicated to a professor emeritus who has made an extraordinary contribution to the enhancement of undergraduate life at Caltech. SURF has been dedicated to Ernest Swift, Lee DuBridge, Robert Sharp, Ray Owen, and this year, to Hans Liepmann.

If you love science. math, or engineering, there is no better program [than SURF] to let you do research and spend a whole summer getting to know a technical field better. If you're not sure whether or not you love science, but if you think there's a good chance, experience a summer doing it outside the classroom. Science is not science classes.

The beginning of SURF's second decade saw the largest SURF class ever, more non-Caltech students participating in the program than ever before, an increase in the amount of funding raised, and a diversity of off-campus projects. This year brought new challenges to the SURF team with the departure of SURF founder, and Administrative Committee chairman, Fred Shair.

Administrative Changes

Dr. Terry Cole, chief technologist at JPL and senior faculty associate in chemistry and chemical engineering, has assumed the chairmanship of the SURF Administrative Committee. He will lead the committee in setting policy and advising the Caltech administration on the long-range planning and development of the SURF program and possible related programs which may be developed. Dr. Cole has been a member of the committee since its formation in 1984 serving as a liaison with JPL.

Dr. Cole received his PhD from Caltech in 1958. Following a number of years in industry, he returned to Caltech in 1976 as a Sherman Fairchild Distinguished Scholar. In 1979 he was a research associate in chemistry and has been in the Caltech-JPL community ever since.

Carolyn Merkel, who has served as administrative assistant to the SURF program since 1981, was named director of the program. Ms. Merkel has worked closely with the students, research sponsors, Administrative Committee members, and the SURF Board. She serves on the governing board of the National Conference on Undergraduate Research and has participated in all three national conferences. In 1991, the conference will be held at Caltech, and Ms. Merkel is chairperson of the planning committee.

Beginning this year, SURF reports to the administration through Vice Provost David Goodstein.

Financial Notes

SURF's financial status was strong in 1989. Contributions from the Institute, JPL, individuals, corporations, foundations, faculty grants, and income from endowments totalled \$689,976. Administrative expenses remain at 11% of the cost of the stipends. We are grateful to Caltech's administration for underwriting expected, but not received, contributions and College Work-Study funds. This enabled us to fund all outstanding proposals. We deeply appreciate the loyalty and continued financial support of the friends of SURF. And we thank the faculty and IPL for their increased financial commitments to this year's program.

NSF Grants

Caltech was the recipient of two grants, one in chemistry and one in computing and information science, from the National Science Foundation's Research Experiences for Undergraduates (NSF-REU) program. These grants funded a total of 26 students, 9 from other institutions.

Endowments

Nine new endowments have been established this year. The income from each \$50,000 endowment will provide funding to support one SURF student each year in perpetuity.

Mr. Hugh F. Colvin established the Hugh F. and Audy Lou Colvin International Fellowship Endowment. The income from this fund will be used toward the stipend for a Caltech student to SURF abroad, or it may be used for a foreign student to come to Caltech to participate in the SURF program.

Mr. Colvin also contributed the initial funds to each of five new endowments established to commemorate distinguished members of the Caltech faculty. The faculty members honored are:

Donald S. Clark (1906-1976), a Caltech alumnus and pioneering metallurgist, who served on the Institute's faculty for more than 40 years.

William Noble Lacey (1890-1977), a principal founder of Caltech's internationally known chemical engineering program and a member of the chemistry and chemical engineering faculty from 1916 to 1977.

Thomas Hunt Morgan (1866-1945), professor of biology at Caltech from 1928 to 1945 and recipient of the 1933 Nobel Prize in Physiology or Medicine for his discoveries concerning the relationship of chromosomes to heredity.

Arthur Amos Noyes (1866-1936), the founder of Caltech's chemistry program, the director of chemical research at the Institute from 1916 to 1936, and founder of Caltech's first undergraduate research program.

Ernest Haywood Swift (1897-1987), a Caltech alumnus, member of the Caltech chemistry faculty from 1920 to 1987, and chairman of the Division of Chemistry and Chemical Engineering from 1958 to 1963.

Mr. Colvin contributed initial funding for the Professor Fredrick Harold Shair SURF Endowment to honor Dr. Shair for his outstanding leadership in founding and directing SURF over the past 11 years.

An endowment was established this year in memory of Peter A. Lindstrom (SURF-87 and -88), a senior in chemistry, who died in an automobile accident on July 1, 1988. Peter had just begun to work on his second SURF project and was profoundly dedicated to research. This endowment will support a student in chemistry. The Associates of Northern California, under the leadership of Mr. Frederick W. Drury, Jr., Dr. Hubert E. Dubb, Mr. William N. Harris, and Mr. Fred W. Morris, have established a SURF endowment to support a SURF student from the northern California area each year. We applaud the vision of this group to take steps to perpetuate a SURF award for a student from their region.

Torchbearers

The Institute recognized several donors as "Torchbearers" for their generous support of the SURF program in their wills, through charitable trusts, or by other lasting gifts such as scholarships or endowments. The Torchbearer designation is derived from the Caltech logo. Vice President Theodore P. Hurwitz presented Torchbearer certificates to: Arthur Adams, Marcella and Joel Bonsall, Hugh Colvin, and Samuel and Frances Krown.

SURF Board

We welcome the following new members to the SURF Board this year: Mr. William Harris, chairman of the northern California regional committee of The Associates; Mr. Alfred Schaff, assistant to the president, AMETEK, Inc.; and Mr. Lindsey Lindemann, manager, college relations, TRW Inc.

The SURF Board is a voluntary support organization consisting of individuals who are dedicated to the educational values of undergraduate research at Caltech, and who, through their advice, encouragement, and financial support, contribute to the vitality, continuity, and effectiveness of the SURF program.

SURF Proposals

The proposal process commences in early January when students begin talking with faculty or JPL technical staff. Together, the student and sponsor develop and define the SURF project. This early interaction is important; it permits the student and sponsor to establish a working relationship and allows the student to acquire background information about the project. This shortens the time it takes for the student to become a productive member of a research team.

When the research sponsor and student agree on a project, the student writes a proposal, which is first evaluated by the sponsors and then submitted to the SURF office along with three letters of recommendation from other members of the Caltech community. Because the sponsors give the proposal an initial and very critical screening, very few weak proposals are submitted to the SURF office.

Proposals and letters of recommendation are reviewed by members of the SURF Administrative Committee: each member reads the proposals in his or her area of expertise. The reviewers assess the enthusiasm of both the sponsor and the student for the project and recommend awards as follows: (1) Outstanding proposal-sponsor extremely enthusiastic, strong letters of recommendation, must fund; (2) Excellent proposal-sponsor enthusiastic, strong recommendations, recommend funding; (3) Good proposal-sponsor moderately enthusiastic, good recommendations, fund if money is available; (4) Weak proposal-sponsor neutral, references neutral, recommend no funding. The number of students awarded a SURF is contingent upon the amount of money available for stipends. The overarching goal of the program is to fund every proposal ranked "outstanding" or "excellent."

The Year's Highlights

Non-Caltech SURFers

Thirty-one students from 22 colleges and universities engaged in research projects at Caltech and JPL. Colleges and universities represented were Bates, Beijing, Brown, Clark, Fresno Pacific, Harvard, MIT, Morehouse, Occidental, Pomona, Reed, Spelman, Stanford, SUNY/Buffalo, Texas A&M, UCLA, UC Santa Cruz, Santa Rosa Junior College, University of Chicago, University of Colorado, Vassar, and Williams.

Professors Charles J. Brokaw, Henry A. Lester, and Mark A. Tanouye of biology recruited students through the Minority Access to Research Careers (MARC) program at the Atlanta Universities, which resulted in students from Clark, Morehouse, and Spelman participating in SURF. Other SURFers recruited by biology professors were from Bates, Santa Rosa JC, and Williams.

Awards and Honors

Craig Sosin (SURF-88 and -89) was awarded a College Achievement Award, presented by Time and Volkswagen United States. Twenty winners were selected from an applicant pool of 600 on the basis of academic excellence and proven achievement in areas outside the classroom. Craig was honored, in part, for his 1988 SURF project "The Galactic Warp in IRAS Sources," which confirmed a warp in the plane of the Milky Way Galaxy. The project was sponsored by S. George Djorgovski, assistant professor of astronomy. Sosin received a \$3,000 scholarship and a trip to New York City for the awards banquet, and was featured in the May 22 issue of Time.

Vivian Chow (SURF-89) was selected by *Glamour* magazine as one of the top ten college women for 1989. She was honored for her academic excellence and work experience in the category of science and technology. Chow worked on her SURF with Charles Seitz, professor of computer science, on a link between telephones and computers.

Twelve SURFers who graduated in June received awards this year:

Mihai Azimioara (SURF-87), an honor graduate in chemistry, Azimioara was given the Richard P. Schuster Memorial Prize, which is awarded on the basis of academic promise and financial need.

Thomas Bewley (SURF-88), an engineering and applied science major, was one recipient of the Donald S. Clark Memorial Awards, 1988, which recognizes service to the campus community and good academic performance.

Cameron Campbell (SURF-87 and -88), received the Rodman W. Paul Prize which is awarded to a senior who has displayed an unusual interest in and talent for the study of history. Stanley Chen (SURF-86 and -87), won the Herbert J. Ryser Memorial Scholarship, 1988, for academic excellence in mathematics.

Rachael Clark (SURF-86 and -87) and Randy Levinson (SURF-87) each received the George W. Green Memorial Prize, given by the division chairmen, to honor students who have shown outstanding abilities and achievement in creative scholarship. Gabriela Cornejo (SURF-88) was awarded the Frederic W. Hinrichs, Jr., Memorial Award at commencement. It is given by the undergraduate deans to the senior who has made the greatest undergraduate contribution to the welfare of the student body and whose qualities of leadership, character, and responsibility have been outstanding. Quynh-Thu Le (SURF-86, -87, and -88), a dual chemistry-biology major, received the Arie J. Haagen-Smit Memorial Award, 1987, for showing academic promise and for making recognized contributions to Caltech. Harvey Liu (SURF-87), was awarded the Artur Mager Prize in Engineering

Summary of the Applicant Pool Number of Caltech applicants 202 Number of non-Caltech applicants 38 240 Total number of applicants Summary of the Recipient Pool Number of Caltech students receiving awards 157 Number of non-Caltech students receiving awards 31 Total awards 188 Percentage of Caltech applicants receiving awards 78% Percentage of eligible Caltech student body-entering 26% sophomores, juniors, and seniors-participating in SURF Median GPA of participants 3.5

for excellence in scholarship and the promise of an outstanding professional career.

Karen Oegema (SURF-88), a chemistry major in the upper five percent of her class, received the Jack E. Froehlich Memorial Award, 1988, for showing outstanding promise for a creative professional career.

Mark Rintoul, III, (SURF-87 and -88) won the Masters' Cup which is presented to an undergraduate whose concern for fellow students has been demonstrated by persistent efforts to improve the quality of undergraduate life and by effective communication with members of the faculty and administration. *Tzejen James Shih* (SURF-86) was one winner of the Mary A. Earl McKinney Prize in Literature, which is given to cultivate proficiency in writing.

Seminar Series

For ten Wednesdays this summer, the SURF Seminar Series was presented by a member of the faculty or JPL technical staff. The sessions were open to anyone at Caltech or JPL and to the public. Speakers for this summer were: Charles A. Barnes, professor of physics, on "Nuclear Fusion: Some Like It Hot, Some Like It Cold"; Earl Freise, director of sponsored research, on "Sponsored Research and Caltech"; Harry B. Gray, Beckman Professor of Chemistry and Director of the Beckman Institute. "Solar Photochemistry"; Hans G. Hornung, Johnson Professor of Aeronautics and Director of GALCIT, "Experimental Research in Real-Gas Hypersonic Flow"; and Jeffrey Hall, member of the technical staff, JPL, "L.A. to Mars: Visualization and Science Movie Making."

Also speaking during the seminar series were: Daniel J. Kevles, Koepfli Professor of the Humanities, "Science, Politics, and Society; the Question of

Summary of the 1989 SURF Class

Divisions and Options	No. of Sponsors	No. of Students
Industrial Relations Center	1	1
Biology	18	28
Chemistry and Chemical Engineering		
Chemistry	11	24
Chemical Engineering	2	3
Engineering and Applied Science		
Aeronautics	3	3
Applied Microbiology	1	2
Applied Physics	4	6
Computer Science	2	4
Electrical Engineering	5	7
Environmental Engineering Science	1	1
Mechanical Engineering	4	5
Geological and Planetary Sciences		
Geology	1	2
Planetary Science	5	6
Humanities and Social Sciences		
Economics	1	1
History	2	3
Literature	2	1
Social Science	6	7
Physics, Mathematics and Astronomy		
Physics	10	17
Mathematics	5	6
Astronomy	3	3
JPL	28	54
Off-Campus	4	4
TOTAL	119	188



National Security"; Jean-Paul Revel, Ruddock Professor of Biology, "Cellular Telephones of the First Kind"; Thayer Scudder, professor of anthropology, "Development of Flood Plains"; Thomas A. Tombrello, professor of physics, "Well Logging for Fun and Profit"; Ewine van Dishoeck, assistant professor of cosmochemistry and planetary science, "Molecules Between the Stars."

Leadership Roundtables

AMETEK, Inc., has again sponsored the SURF Leadership Roundtable Series, which provides students with the opportunity to meet with leaders in academia, industry, or government to

discuss topics such as career development, academic versus industrial research, moving from research into management, careers in a matrix organization, or personal values in career development. This year's Roundtable leaders included: Martin Apple, president of ADYTUM, Inc.; Dr. Eleanor Helin, geology and planetology section, JPL; and Robert L. Shafer, certified management consultant. Also participating were Caltech alumni M. A. Kaplan, executive vice president for customer services, Pacific Bell; Robert Perpall, retired vice president and general manager of Garrett Corporation, Airesearch Industrial Division; Jeffrey Richardson, division leader, chemical sciences division, Lawrence Livermore National Laboratory; and Alfred Schaff, assistant to the president, AMETEK, Inc.

SURF/Caltech Y Program

Joan Spears, together with Caltech Y staff and a large group of SURFers, planned an expanded program of social activities this year. Events included a special behind-the-scenes look at Disneyland, as well as trips to Universal Studios, the Shubert Theater to see *Les Miserables*, the IMAX Theater, the Ice House Comedy Club, Raging Waters, and a Dodger game. SURFers also took beach trips, went horseback riding, and participated in the first SURF softball team.

Seminar Days

The culmination of the SURF program each year, SURF Seminar Day, was held on Saturday, October 21. Students, faculty, parents, and friends of SURF gathered on the campus to hear the SURFers give 20-minute oral presentations of their projects during 18 concurrent sessions. Seminar Day activities began with a buffet lunch in Dabney Garden, followed by the sessions from 1:00 to 4:30 p.m. President and Mrs. Everhart hosted a reception in their garden following the presentations for the SURFers, parents, alumni, sponsors, and others attending Seminar Day.

Students who had to leave Caltech to return to their home campuses for the fall term presented their final oral reports on August 10. In 4 concurrent sessions 30 students gave 20-minute presentations to audiences of students, research sponsors, members of their research groups, faculty, and staff.

National Conference

The third annual National Conference on Undergraduate Research, hosted by Trinity University in San Antonio, was held in April. Nine students represented Caltech and gave lectures on their projects. Harry Gray, Beckman Professor of Chemistry, delivered the keynote address for the conference.

Caltech will host the fifth annual National Conference on Undergraduate Research in 1991, as part of the Institute's centennial celebration. The conference will bring approximately 1000 students and 300 faculty and staff, representing more than 200 colleges and universities, to Caltech. It is fitting that the Institute, which is so deeply committed to research, should encourage undergraduates, not only at Caltech but nationwide, to participate in scientific research and scholarly activities.

JPL SURF Report

A new feature of this year's JPL SURF program was a Friday Seminar Series held at JPL with presentations by JPL technical staff members. Seminars were presented by: James Breckinridge, section manager, optical science and applications, "Optical Sensing Engineering for Remote Sensing Instruments"; Charles Elachi, assistant laboratory director, office of space science and instruments, "Space Remote Sensing Observations Across the Electromagnetic Spectrum"; C. Bernard Farmer, atmospheric and oceanographic sciences section, "Infrared Measurements of the Composition and Stability of the Atmosphere"; Carl Kukkonen, director, center for space microelectronic technology, "Overview of the JPL Center for Space Microelectronics Technology"; Mario Molina, senior research scientist, "The Antarctic Ozone Hole"; and Joseph Yuen, telecommunications science and engineering division, "Communication Across the Solar System."

Dr. Lew Allen, director of JPL; Dr. Terry Cole, chief technologist; and Dr. Kirk Dawson, assistant laboratory director, had a luncheon with the students. The topic of their presentation was "The Future of Planetary Exploration."

As Voyager 2 neared the end of its grand tour of the planets, Professor Edward C. Stone, project scientist and vice president for astronomical facilities, and Dr. Cole briefed Caltech and JPL SURFers on the expectations for Voyager 2 at Neptune.

In order to strengthen the bridge between Caltech and JPL SURFers, a SURF office at JPL, staffed on Fridays, was opened to serve the students.

Speaker's Bureau

Twenty students participated this year in the SURF Speaker's Bureau, coordinated by Jean Cass. Many groups invited students to speak, including: The Associates of Northern California; the dean's office for Parent's Day; alumni chapters in Portland, Seattle, and Phoenix; the admissions office, which hosts Decemberfest; and the Pasadena Mental Health Center. Students also spoke at the SURF Kickoff Dinner.

In addition, nine students spoke to the California Scholarship Federation, hosted on campus by the admissions office, and three spoke at Alumni Seminar Day. Service groups, school science classes, the JPL Boy Scout Troop, and St. Mark's Girl Scout Troop also hosted lecturers.

Middle School Pilot Project

Jean Cass has developed a three-year pilot project to enhance the science curriculum at local junior high schools. Together with several members of the SURF Speakers Bureau, Jean produced a series of presentations which were given to junior high school students at La Cañada High School, Rosemont Junior High School in La Crescenta, Washington Middle School in Pasadena, and St. Mark's School in Altadena. The students gave presentations on physics, chemistry, optics and lasers, the human nervous system, the human immune system, astronomy, and air pollution. The presentations included demonstrations and hands-on experiments.

The purpose of the pilot project is to interest young people in science, with the hope that some will choose a career in scientific research, and that most will develop an awareness of and interest in science. It also encourages SURFers to invest their knowledge, education, and enthusiasm for science in younger students; not only during their participation in the project, but as they progress in their careers.

Teachers and principals have responded enthusiastically to this effort and encouraged its continuation.

Biology

Exploring Gap Junctions With Microscopy

Jeannie Barrett Sponsor: Jean-Paul Revel

Gap junctions chemically and electrically connect cells. They are found in the cells of most multicellular animals. With transmission electron microscopes, the gap junction and its protein components can be seen. With light microscopes, the presence of gap junctions can be detected by observing dye transfer between cells. The confocal microscope, a newly developed light microscope, allows for detailed viewing of thick 3-D tissue. This facilitates the study of the patterns that gap-junction-connected cells form in tissue.

Cytoskeletal and Adhesion Proteins of the Mesozoan

Sandip Biswal Sponsor: Jean-Paul Revel

One approach to understanding the genesis of multicellularity is to examine the types of intercellular contacts which exist in organisms believed to be close to the base of the phylogenetic tree. In this project, we have used the Mesozoan, one of the most primitive of all extant today, and have attempted to establish a relationship between extracellular components (such as laminin, fibronectin, collagen Type IV, and elastin) and cytoskeletal proteins (such as gap junctions, myosin, actin, tubulin, desmoplakin 1 & 2, and spectrin) components from the Mesozoan to those of higher organisms by primarily using immunolabelling studies.

Project SEED

Charles Blake Sponsor: James Bower

Project SEED is an educational research project investigating the efficacy of computer simulation kits at the elementary school level. Prior SURF projects have developed an interactive simulation illustrating corn growth. This summer we wanted to broaden the educational scope of the program from agriculture to other sciences. My work consisted mainly of making the sky scenery realistic.

It was necessary to speed up the animation considerably. Celestial sphere coordinate transformations had to be coded. Planetary position calculations were later included. The limited number of fixed stars which could be rapidly displayed were hand selected and manually entered. The length of the day and night was made to vary. Finally, constellation identification assistance was included in the program. The simulation is now both an agricultural and an astronomical teaching tool.

Internal Perfusion of Xenopus Laevis Oocytes Using Glass Pipettes

Gavin Chilcott Sponsor: Henry Lester

Xenopus laevis oocytes, with their aptitude for mRNA-mediated functional expression of exogenous excitability proteins, provide a powerful assay system for the study of the structure and function of both cloned excitability molecules and those occurring naturally in other species. However, studies of protein function and coupling to second messenger pathways could be improved with a robust system for simultaneously controlling the internal and external solutions of the cell. This was attempted using small glass pipettes both to hold the oocyte, and to perfuse its interior.

Project SEED

Mark Dinan Sponsor: James Bower

Project SEED is devoted to improving science education in elementary schools. To help accomplish this, we have written several computer simulations for the Macintosh to accompany a set of hands-on-science kits used in the schools. I improved the Corn Growing Simulation to make it more user friendly by polishing its graphical interface, by including hooks to link it with a bibliographical database, and by providing teachers with an easy means of keeping track of their students' progress through the simulation. To do this, I used the Hypercard[™] application extensively.

Isolation of Homologous Genes to Fasciclin I in Drosophila Melanogaster

Oguz Ersoy Sponsor: Kai Zinn

Fasciclin I is a neuronal surface protein from insect embryos that is a candidate for a molecule involved in growth cone guidance. We were interested in determining whether other molecules related to fasciclin I exist in insects and also whether a fasciclin I homolog exists in vertebrate embryos. By performing the Polymerase Chain Reaction (PCR) using five degenerate oligonucleotide primers that were synthesized based on three blocks of fasciclin I sequence conserved between Drosophila and grasshopper, cDNA from 12 hour old Drosophila embryos and from zebra fish embryos was screened for sequences homologous to fasciclin I. In both species, one combination of primers gave a novel amplification product that was the same size as the authentic fasciclin I cDNA amplification product but was resistant to digestion by restriction enzymes that

cut within the amplified region of the fasciclin I cDNA. This finding was supported by PCR experiments with cDNA from *Drosophila* mutants which do not express fasciclin I. Amplification from this mutant cDNA population also produced an amplification product of the predicted size.

Muscle Fiber Elimination During Synapse Elimination

Eric Fung Sponsor: David Van Essen

Synapse elimination is a developmental process in mammalian skeletal muscle. Beginning shortly after birth and continuing up to about two weeks postnatally, synapses in the rabbit soleus are eliminated until muscle fibers are singly innervated. This project examined the question of whether muscle fibers are eliminated as well. Soleus muscles were dissected out of rabbits of varying ages between four and thirty-five days. Muscles were then frozen and sectioned. Staining of sections with alkaline ATPase allowed visualization of individual muscle fibers, which were then counted from photos of sections. Preliminary data suggest that no change in muscle fiber number occurs.

Selection of Mutants Using the Gene-Fusion Approach

Milind Gangal Sponsor: Scott Emr

Proteins destined for secretion in an eukaryotic cell proceed along a welldefined pathway called the secretory pathway. Several organelles also use the secretory pathway to import essential proteins. We have used the genefusion method to locate the signal designating a protein for retention in

the Golgi, a pancake-like array of sacks that sort the various proteins using the secretory pathway. The gene-fusion approach involves introducing a gene encoding a hybrid protein into a cell and monitoring secretion, a default destination of the secretory pathway. Our fusion plasmid contains a hybrid protein consisting of a portion of STE13, an enzyme that is bound to the membrane of yeast Golgi, fused to the active part of the enzyme Invertase. Normal cells with our plasmid did not secrete the hybrid protein; therefore, we believe that the part of STE13 fused to invertase contains the signal for retention in the Golgi. We are presently screening for mutants that secrete our hybrid protein.

Identification of Molecules That Define Rostrocaudal Positions in The Mammalian Nervous System

Kimulique Harkley

Sponsors: Zaven Kaprielian and Paul Patterson

The mechanisms responsible for neuronal cell recognition and the specificiy of neuronal connections have been a major area of interest in developmental neurobiology for many years. The mature nervous system is characterized by highly specific stereotyped patterns of connections, and selective synapse formation plays an important role in the establishment of these patterns. It is the interest of this research to define the molecules involved in specific synapse formation.

Determination of Tissue Specific G Proteins in Differentiated Hematopoietic Cells

Sean Johnston Sponsor: Melvin Simon

GTP-binding proteins, or G proteins are a family of proteins that are involved in signal transduction in many cell lines. The G protein, which is activated following the binding of a ligand to a specific receptor, in turn activates other enzymes. Hematopoietic, or white blood cells, are known to utilize the G protein transduction system, and it is theorized that one or more G proteins are involved in the differentiation mechanism that transform stem cells into fully mature cell lines. As G proteins belong to a "gene family," there exist regions within the DNA coding the protein that are very similar to each other in all members of the family. This phenomenon allows for the use of the Polymerase Chain Reaction (PCR) technique developed by the Cetus Corporation to detect all members of the gene family which exist within the cell and to amplify a specified segment of DNA for further characterization. These DNA fragments can then be purified, separated, and sequenced, which would reveal novel members of the gene family. Utilizing the PCR fragment as a probe, the gene encoding the novel protein can be obtained. The presence of these novel proteins in unrelated cell lines can then be checked in order to determine whether the protein is ubiquitous or specific to the hematopoietic cell line.

Pattern of Innervation by Fiber Type in the Neonatal Rabbit Soleus Muscle

Yu-Hung Kuo Sponsor: David Van Essen

In the neonatal rabbit, several neurons synapse onto individual muscle fibers. a state known as polyinnervation. Synapse elimination occurs as the animal develops to result in the singly innervated state observed in adults. During the polyinnervated state, the muscle fibers have already differentiated into two classes, fast and slow, which can be distinguished by their physiological and histochemical properties. We are examining the pattern of innervation in the two muscle fiber classes. If differences exist in the degree of polyinnervation, it is likely that fiber type plays a role in governing the rate of synapse elimination.

Purification of Clam Tubulin

Ngocdiep Le Sponsor: Jean-Paul Revel

Clam tubulin subunits were isolated and purified using the method described by H.W. Detrich, III, with modifications. Their molecular weights were identified by SDS-Polyacrylamide Gel Electrophoresis (SDS- PAGE) followed by Coomassie Blue staining. The preparation was further characterized with greater sensitivity using silver staining protocol. Temperature dependence of clam tubulin's solubility was attempted.

The Search For a Protein Involved in the Inactivation of Rat Brain Sodium Channels

Ralph Lin Sponsor: Henry Lester

Because of their integral role in neuronal signal propagation, voltage gated sodium channels have been studied since their discovery in 1952. The most common form in a rat brain consists of three subunits: α , β 1, and β 2. By injecting α subunit RNA into Xenopus oocytes, we have observed that the α subunit's electrophysiological characteristics are different than those of intact sodium channels. However, upon injecting α subunit RNA along with low molecular weight messenger RNA (mRNA) from the rat brain, the native properties of intact channels are restored. This low MW mRNA may encode the β subunits or other proteins that are responsible for these electrophysiological changes. We are currently trying to isolate this protein by dividing the low MW mRNA pool into groups of 5000 RNA messages. By then amplifying each group to larger quantities of mRNA, we are able to inject 5000 messages into Xenopus oocytes along with α subunit RNA and subsequently look for any change in electrophysiological properties. By this method of screening, we hope to eventually purify the particular RNA species encoding this protein and shed light on the process of how this protein affects the α subunit.

Isolation of Vps15 Suppressors

George Yen-Hsi Liu Sponsor: Scott Emr

Vps15p is an important component of a pathway responsible for the localization of yeast vacuolar proteins. Sequence analysis has shown that Vps15p shares significant homology to the catalytic subunit of the serine/threonine protein kinase. Previously, it has been demonstrated that single amino acid substitutions in this kinase domain inactivate the function of Vps15p. In an effort to study components that interact specifically with this protein, I have isolated and analyzed a number of strains that appear to suppress the single amino acid defects in Vps15p.

Molecular Biology of Human Potassium Ion Channels

Merion Stewart Sponsor: Mark Tanouye

The molecular biology of potassium (K⁺) ion channels is of interest to researchers for several reasons; namely, K⁺ channels may be present in all eukaryotic cells and contribute to several cell functions: action potential repolarization, cardiac pacemaking, and possibly learning and memory. It has been reported that the Drosophila Shaker (Sh) gene codes a type of voltage sensitive K⁺ channel and the gene has been cloned. Using the polymerase chain reaction, six different K⁺ channel sequences were amplified from human genomic DNA (Kamb et al., Proc. Natl. Acad. Sci., in press), and used to probe cDNA libraries prepared from human brain. cDNA corresponding to 5 of the 6 amplified fragments were isolated and sequenced. A-type potassium currents are expressed in Xenopus oocytes injected with in vitrosynthesized transcripts from cDNA for the Drosophila Sh locus. 5' untranslat-

ed regions, however, often lead to a lack of protein expression by the oocytes. This work examines the possibility of increasing expression in the oocyte modeling system by creating constructs with 5' untranslated sequences cleaved. Several restriction digests were done with a vector containing fragments of the cloned human K⁺ DNA. Gel electrophoresis revealed that 4 constructs should serve further research by cleaving the 5' untranslated region from each DNA, thus the constructs were made. Additional restriction digests and sequencing revealed that the constructs were those desired. Injection of the DNA constructs into Xenopus oocytes will be performed at a later date.

Crystallization of Proteins for X-ray Crystallography

Tannishtha Sponsor: Pamela Bjorkman

The AIDS virus attacks the immune system and wears away our normal response to diseases. The CD4 protein bound to helper T-cells acts as a receptor to the virus. Understanding the structure of the binding site can explain the mechanism of attachment and possibly suggest a cure. We worked on crystallizing the entire CD4 protein and also produced a fragment containing the binding site of interest. Later, this fragment will be purified and crystallized for use in structural analysis through X-ray crystallography. We also used similar techniques in order to crystallize Enterotoxins produced by Staphylococcus Aereus.

Characterization of IL2-CAT Transgenic Mice

Chandra Tucker

Sponsors: Ellen Rothenberg and Julia Yang

In the immune system, the IL2 gene is a major regulator of T-cell proliferation, and is expressed in helper T-cells. My project involved studying this gene in specifically designed transgenic mice-fertilized mouse embryos that had been previously injected with an IL2-CAT gene construct and then implanted in pseudo-pregnant foster mothers. Progeny were screened for the IL2-CAT transgene using polymerase chain reaction (PCR) amplification to increase the number of copies of the gene so positive clones could be detected through DNA blotting techniques. By analyzing the IL2-CAT protein activity in such animals, one can learn more about the tissue specificity of IL2 gene expression.

Characterization of Genes Expressing Inflorescence in Arabidopsis Thaliana

Tracy Wilson

Sponsors: Elliot Meyerowitz and John Bowman

Understanding the molecular basis by which cells communicate to develop precise patterns of organ primordia in flowering plants is the purpose of this study. The analysis of agamous, a particular hometic floral mutant in Arabidopsis with the specific phenotype of a flower within a flower, was generated by T-DNA insertional mutagenesis. The genomic region surrounding the insertion was cloned and used to isolate cDNA clones of the region. Classification and assortment of these clones introduced a gene adjacent to agamous which also exhibits expression in the flowering structures of

ABSTRACTS

Chemistry and Chemical Engineering

Arabidopsis. It is this adjacent gene which is localized and sequenced in order to further the understanding of flower development.

Project SEED

Linda Ying Sponsor: James Bower

This project is an improved version of the same project ("Growing Seeds") which began last year. Its target is third grade elementary school children. They can learn about the different aspects of growing corn, from the number of acres needed for a cornfield to the microscopic structure of corn, just by using a computer program. For example, they can learn more about the set-up of a farm, the growing cycles of corn, the necessities of growing corn, the cellular structure of corn, and other interesting topics.



Synthesis Characterization and Electrochemistry of Cobalt Cyclan Complex

Fred Ayres Sponsor: Fred Anson

The macrocyclic cobalt complex, *trans*-[Co([14]aneN₄)(OH₂)₂]³⁺ was examined by mercury electrode between the pH range 0–14. The Pourbaix plot of potential (Epo) versus pH has a slope of 12 ± 10 mV between pH 0 and pKa₁ (2.9), a slope of -78 ± 10 mV between pKa₁ and pKa₂ (7.2), and a slope of -115 ± 10 mV for pH > pKa₂. These values are in agreement with theory.

Models for Red Blood Cells in NMR and Diffusion Studies

John-David Bondy Sponsor: John Roberts

We investigated the diffusion and NMR relaxation properties of two potential models for red blood cells. The first model system is a solution of polystyrene microspheres available from Rohm & Haas. We used a 500 MHz Bruker NMR spectrometer to study their spectrum and to determine how permeable they are to water. The second model system was the so-called blood cell ghost, which is a blood cell with its contents removed. The T2 relaxation of "plain" blood cell ghosts was determined and compared with the T2 of ghosts filled with a nickel compound, as well as ghosts treated with a mercury compound that suppresses diffusion across the membrane. In this way we hoped to evaluate the factors responsible for the T2 relaxation of blood in vivo.

Spectroscopy of Molecular Ions and Clusters

Andrew Chen Sponsor: Mitchio Okumura

The goal of this SURF was to build the vacuum chamber for a pulsed ion time-of-flight mass spectrometer. The chamber achieves a pressure of 10^{-4} torr in the ion-producing region and 10^{-8} torr in the detection region. The mass spectrometer will be used to find the structure of molecular ions, such as Co-H₂ and (CH₄)⁺, and clusters, such as Br₂⁻ (CO₂)_n.

Gas Phase Reactions of Co⁺

Nathan Diachun Sponsor: Jesse Beauchamp

The research focused on the gas phase reactions of ligated atomic cobalt ions. All reactions took place in an ion cyclotron resonance cell, which was also used for product detection. It was determined that one ammonia ligand deactivates cobalt from reacting with butane, while $Co(H_2O)^+$ does give a number of products. We are still characterizing these products.

Site Directed Mutagenesis of β -Lactamase and the Role of General Recombination in the Excision of Gene Inserts in the M13 Bacteriophage

Michael Ehlers Sponsor: John Richards

A mutagenic technique that "saturates" a particular site in a protein with all possible amino acid substitutions by using the bacteriophage M13 was used in an attempt to begin the study of the role of residue 66 in β -lactamase. Phenylalanine 66 is part of a dyad (Arginine 65, Phenylalanine 66) that is conserved in most class A β -lactamases.

Mutagenesis reactions were done with four different oligonucleotides, to "saturate" the codon for residue 66 with the bases necessary to obtain all 19 mutants. The products of the reactions were used to transform the TG1, JM101, and XLIB strains of Escherichia coli cells. Isolation and analysis of the mutant gene-containing M13 DNA revealed the occurrence of a spontaneous recombinatory deletion of approximately 3000 base pairs in approximately 85% of the M13 DNA samples obtained from the TG1 and JM101 strains, and in approximately 25% of the samples obtained from the recA XLIB strains. Restriction mapping revealed that the deletion was occurring in the region of the inserted gene. This dramatic drop in deletion occurrence indicates that the recA protein of E. coli may be involved in the splicing out of DNA inserted in the M13 bacteriophage.

Fabrication and Characterization of n-Silicon Metal/Insulator/Semiconductor Devices

Delwyn Gilmore Sponsor: Nathan Lewis

Traditional metal/Silicon Schottky diodes have limited flexibility in that their barrier heights are pinned between 0.7 and 0.9 volts, regardless of the metal used. In the course of studying the n-Si/CH₃OH junction in photoelectric cells, N.S. Lewis and M.D. Rosenblum discovered that the barrier height became unpinned. Anodic deposition of a very thin insulating layer on the surface was proposed as the mechanism. This project continues to research the best procedures for manufacturing unpinned diodes. Also, characterization of the insulator on the silicon surface is attempted.

Sensitive Detection of Ion Magnetic Resonance

Tanya Kurosky Sponsor: Daniel Weitekamp

Cyclotron resonance techniques have been proposed as a novel method of obtaining magnetic resonance spectra with a sensitivity twenty orders of magnitude greater than that of conventional techniques. In the design, the cyclotron frequency of trapped ions is coupled to the spin state by a magnetic bottle field. Thus, magnetic resonance spectra can be derived by detecting changes in the cyclotron frequency after a series of spin flips. My work has been to mathematically remove the effects of damping from the detected cyclotron signal and to do calculations of the currents and magnetic fields needed for the apparatus.

NMR Imaging of Solids

Thomas Lenosky Sponsor: Daniel Weitekamp

Line broadening can degrade image resolution in solid-state NMR imaging experiments. Several new multiplepulse sequences with superior properties for imaging experiments are developed and tested using existing computer simulations. Pulse sequence properties are predicted using the Magnus expansion of coherent averaging theory. These sequences minimize higher order correction terms containing dipolar interactions of spins, chemical shift contributions, and imaging frequency offset, which contribute to NMR line broadening. The radio frequency (RF) magnetic field inside a helically wound conducting strip is approximated by means of cylindrical multipole expansion. The RF field results from an external coil used in an NMR imaging experiment. This result can be used to produce quantitative

predictions of image distortion in planned one- and two-dimensional imaging experiments.

TL: Concurrent LU Factorization

Alvin Leung Sponsor: Manfred Morari

The goal of my research project was to study the performance of the LU factorization algorithm (linear algebra) on the concurrent computer. Its performance is important because the LU factorization algorithm is used to solve large systems of linear equation, and solving such large systems is essential for VLSI circuit simulation, structural analysis, and chemical engineering applications, for example. The LU factorization algorithm is implemented in full and sparse libraries. I have studied and improved both libraries. Since most applications require solving large sparse matrices. I have concentrated my effort on the sparse matrix solver. My studies show the performance of the sparse solver is sensitive to the data structure used. Any inefficiency in either code or data structure will degrade the performance significantly. Since the sparse matrix solver has shown reasonable speedup, it is feasible to exploit the structure of the matrix to further reduce the amount of computation required to factorize a matrix. We present our speedup results and suggestions for future work.

Elucidation of Electron Transfer in Blue Copper Proteins by Site-Directed Mutagenesis

Agnes Lew Sponsors: Harry Gray and John Richards

Long-range electron-transfer (ET) reactions are important steps in many biological processes. Recent advances in recombinant DNA technologies have provided powerful means to design novel proteins that offer convenient routes to study ET mechanisms. Using site-directed mutagenesis, two blue copper proteins-azurin (Pseudomonas aeruginosa) and plastocyanin (Populus nigra var. italica) were optimized for the study of intramolecular electrontransfer mechanisms via the ruthenium modification method. The synthetic plastocyanin gene with azurin signal sequence was cloned into expression vectors pKK223-3 and pUC 18. The gene for azurin with its leader sequence was also synthesized and cloned for expression. Proteins were extracted by osmotic extrusion from the periplasm and purified by ion exchange and gel filtration chromatographies. A series of plastocyanin mutants, Ser 17 - His, Glu 18 - His and Ser 81 - His are now being prepared to investigate the electron transfer pathway.

Conformational Analysis of Succinic Acid Through Measurements of its Vicinal Proton-Proton Coupling as a Function of pH

Eugene Lit

Sponsor: John Roberts

The importance of hydrogen bonding in increasing the K_1/K_2 ratio of di-carboxylic acids for cases in which this ratio is relatively small has been established in the case of succinic acid based on conformational data obtained through the analysis of vicinal protonproton coupling on NMR. The angle between the carboxyl groups in the gauche rotamer was determined for each of the diprotic, monoprotic, and di-ionized species, and the presence of D₂O bridging in the di-ionized species is determined.

Catalytic Studies with Parahydrogen Enhanced NMR Sensitivity

David Norris Sponsor: Daniel Weitekamp

A reaction pathway for the catalyzed hydrogenation of alkenes by 1,2-Bis(diphenylphospino)ethane norbornadiene rhodium(I) hexafluorophosphate has previously been proposed. However, we have utilized the enhanced sensitivity of PASADENA (Parahydrogen And Synthesis Allow Dramatically Enhanced Nuclear Alignment) nuclear magnetic resonance (NMR) to detect a new intermediate. A two-dimensional PASADENA NMR experiment employing a zero or double quantum coherence filter has shown the productive pathway through this intermediate. This not only provides kinetic information about the [Rh bis(diphos)]² mechanism, but also demonstrates the value of the PASADENA NMR technique and its applicability to kinetic studies of hydrogenation reactions.

Stable Protein in Non-Aqueous Solvents

Betty Pun Sponsor: Frances Arnold

Proteins that are stable in non-aqueous solvents are a promising solution to problems like biospecific separations in organic solvents, detection and removal of toxic wastes from organic media, environmental monitoring, and perhaps most importantly, biocatalysis. Through random mutagenesis, mutants of enzymes will be created and a procedure for rapid screening of their activity will be needed to identify the proteins that are more stable in nonaqueous solvents. Such a procedure for screening is developed for the alphalytic protease, one of the proteins to be engineered by the group. The technique involves growing the host cells

that carry the plasmid on a filter paper so that the protein excreted will be adsorbed onto the paper, incubating the paper in the solvent of choice, then assaying the enzyme for filter-bound activity.

A Study of Urea Using NMR Spectroscopy

Mary Katherine Raymond Sponsor: John Roberts

Urea was investigated through 1H, 13C, and "N spectra of three different "Ncontaining ureas and by comparison with ethyleneurea. Proton spectra revealed that, while there is ¹⁴N quadrupolar relaxation in the samples containing ¹⁴N, the protons are not undergoing rapid intermolecular exchange. ¹H and ¹³N spectra showed that there is complex spin-spin couplings in all the samples. Analysis of the couplings showed that there is no chemical shift differences between the protons and the protons are equivalently coupled to the nitrogen to which they are attached. This data, along with comparison of "N and 'N NMR spectra of ethyleneurea and urea, suggest that the NH2 groups of the urea molecule are flipping rapidly about the N-C bonds on the NMR time scale which causes the hydrogens to appear to have equivalent chemical shifts.

Magnetic Resonance Imaging of Colloidal Brain Cysts

S. Lan Smith Sponsor: John Roberts

The SURF project involved using a nuclear magnetic resonance (NMR) spectrometer to measure T_1 and T_2 relaxation times of the hydrogen nuclei in water molecules. These relaxation times are vital to the use of MRI (magnetic resonance imaging) images of the human body for diagnosis of cancer and many other abnormal conditions.

The varying chemical compositions and concentrations in different tissues can give the water protons in different parts of the body strikingly different relaxation times. By measuring the relaxation times of water in solutions with polymers having different functional groups, and by making measurements at temperatures ranging from 6° C to 24° C, this project was planned to reveal how different chemical environments and viscosities change relaxation times. A better understanding of how these factors effect T1 and T2 will enable us to deduce more about the chemical and physical structure of tissues and growths from their MRI images.

Studies in Biomimetic Molecular Recognition

Elizabeth Warner Sponsor: Dennis Dougherty

A water soluble, carboxylate substituted, macrocyclic host molecule has been observed to bind positively charged and otherwise electron deficient guests. The synthesis of a quaternary ammonium substituted host is needed to expand the pH range over which binding studies may be conducted. The di-ester building block 2, 6- bis(tbutyldimethylsiloxy)- 9, 10-dihydro-11, 12-dicarbomethoxyethenoanthracene, was subjected to gentle aminolysis to form the corresponding amide. This was then reduced and treated with methyl iodide to form the quaternary ammonium salt. The siloxy groups were removed and the product was subjected to macrocyclization conditions. Synthesis of chiral hosts is under way.

A High Resolution Optical Parametric Oscillator for High Resolution Spectroscopy of Ions and Clusters

Leon Waxer Sponsor: Mitchio Okumura

A high resolution LiNbO3 Optical Parametric Oscillator (OPO) is in the process of being constructed that is capable of providing a high peak power, narrow linewidth, tunable source of infrared photons. The OPO is pumped by an injection seeded YAG whose linewidth is approximately 0.003 cm⁻¹. With the addition of certain linewidth elements in the cavity, the linewidth of the resonated high frequency (approximately 1.5 um) component of the OPO output can be reduced to produce a low frequency component (around 3.4 um) linewidth of approximately 0.003 cm⁻¹. The OPO has a large tuning range which is scanned by computer controlled movements of the cavity elements. This large tuning range makes the OPO useful for high resolution infrared spectroscopy of ions such as CH4⁺ and for studying molecular interactions with clusters.

Use of Angular Correlation of Radioactivity in Order to Determine Effective Drug Delivery of Reconstituted Viruses in Mice

Alex Wein Sponsor: John Baldeschwieler

In order to study the fusion of reconstituted virus vesicles with liposomes or mammalian cells, a variety of techniques can be employed. This summer, progress was made in improving existing techniques, such as perturbed angular correlation, and fluorescence spectyroscopy. The PAC was utilized to test vesicle stability and to characterize the distribution of certain vesicles in mice.

ABSTRACTS

Engineering and Applied Science

Immobilized Metal Affinity Separations of Proteins

Emily Wen Sponsor: Frances Arnold

Immobilized metal affinity chromatography is a technique to separate proteins by the interaction between certain amino acids on the surface of a protein and a metal chelated on a matrix. In this project, metal chelators with different properties have been synthesized and used to extract proteins in metal affinity aqueous twophase PEG/dextran systems. The results are compared to that of a PEG derivative of iminodiacetic acid, which shows a linear relationship between the logarithm partition coefficient ratio and the number of accessible histidines. It is found that chirality affects the extraction of proteins, and steric hindrance in the structure of the proteins can dramatically reduce the partition coefficient. Further work will be done on testing the charge and steric effects of the chelators.



Synthesis and Cyclization Studies of a Biradical Precursor

John Wendel Sponsor: Andrew Myers

Thiol 1 was synthesized in twentythree steps from commercially available starting materials. This molecule was envisioned to undergo base-induced SN2' displacement to give the intermediate allene 2, which was hypothesized to react further to form biradicals 3 and 4. In the event, treatment of 1 with triethylamine in dimethylsulfoxide at 23°C with 1, 4- cyclohexadiene (4M) gave the products of formal addition of dihydrogen to 3 and 4, supporting the intermediacy of these biradicals. It is hoped that these radicals will be sufficiently reactive to abstract atomic hydrogen from the DNA backbone and thus potentially function as DNA cleaving agents.

Charge-Charge Interactions in Binding and Catalysis by Enzymes: The Role of Lysine-234 in RTEM-1 β -Lactamase

Scot Wolfe Sponsor: John Richards

In RTEM-1 B-lactamase electrostatic interactions between lysine-234 and a critical carboxyl group of the β -lactam antibiotic are believed to play an important role in substrate binding. Mutations at lysine-234 were introduced using site-directed mutagenesis. These mutants reveal how different charged groups at site 234 affect β -lactamase substrate binding and activity. Enzymatic activity of these mutants was assayed using circular dicroism kinetic studies, which allowed an extremely precise measurement of the enzyme Km and kcat. These values, when compared with wild-type enzyme, will help reveal the true role of lysine-234 in the function of β -lactamase.

Shock Wave Consolidation of Metallic Glasses

Joseph Bach Sponsor: Brent Fultz

The objectives of this project were to obtain several samples of bulk metallic glasses by shock wave consolidation, and to investigate their microstructures and mechanical properties. High cooling rates of about one million degrees per second are required in order to obtain a noncrystalline alloy. As a result, metallic glasses are commercially available only in the form of wires or thin ribbons. Such ribbon was obtained and ball milled into powder. A 35 mm howitzer cannon was used to propel a flyer plate, which, upon impact, consolidated the powder into a bulk specimen. The states and microstructures of the samples were investigated using microscopy and x-ray diffraction, and the mechanical properties were investigated using a miniload and a computer controlled hydraulic system.

Stabilization of Arcs in Electric Furnaces

Boyd Bangerter Sponsors: Paul Bellan and Michael Brown

The purpose of the research which has been undertaken is to provide a cheap and efficient method of stabilizing an arc in an electric furnace. The thrust of the project was to construct an arc furnace simulator and magnet coils. The stabilization process could then be tested by applying a coaxial magnetic field to the arc generated in the simulator. This research will benefit the steel industry, which produces roughly one third of all new steel by melting old steel in arc furnaces.

A Robust Analysis of Acoustic Instabilities in Combustion Chambers

Leonard Chen Sponsor: Athanasios Sideris

Acoustic instabilities caused by unsteady burning in combustion chambers have long been a problem, e.g., a phenomenon called "reheat buzz" is often experienced in jet engines. This problem is quite complex to model and difficult to control. The Rijke tube problem was considered since modeling is simpler and was investigated from a control design viewpoint.

The system designed consisted of two lengths of Pyrex tubes, a heating coil, a microphone for a sensor, and a speaker as an actuator placed at one end of the tube. A transfer function was calculated, and from this, a control law was designed. Using this, it is expected that the signal in the tube will be significantly attenuated. This setup can easily be made to closer approximate and thus study the control of more complex combustion chambers.

Spheromak Equilibrium in a Tokamak Vessel

David Cutrer

Sponsor: Paul Bellan and Michael Brown

A small (r = 4 cm), dense (n = 10^{13} cm⁻³) spheromak injected into Caltech's ENCORE tokamak vacuum field is observed to form a stable oblate configuration. In equilibrium, the spheromak magnetic fields have the form e^{imθ} (where m = $\frac{1}{3}1$ and θ is the tokamak's poloidal direction), and the spheromak length is approximately three times its radius. Magnetic field measurements (**B**) were made using two different experimental configurations. First, two quartz covered crossshaped probe arrays were placed at a tokamak cross section on each side of the spheromak entrance region. Each probe measured B at three radial and four angular positions. In addition to showing the m = 1 equilibrium, this data shows that the spheromak develops a helical twist late in its resistive lifetime (~20 microseconds). Also, the spheromak appears to shift in a direction opposite the tokamak toroidal field. Second, a ceramic coated probe measured B at a tokamak cross section on the left side of the entrance region at three radial and eight angular positions. This data confirmed the equilibrium shape of the spheromak, and showed some variation of the equilibrium on the inboard side of the tokamak. The data is fit to a computer model of an ideal m = 1 spheromak in an infinite cylindrical geometry. This fit gives information about the magnetic energy and helicity of the spheromak, and provides a means for examining the experimental deviations from the ideal mode. Ultimately, detailed knowledge of this equilibrium will lead to a greater understanding of how spheromaks can be used to inject plasma density and magnetic helicity into a tokamak discharge.

A High-Level Language Processor Based on the ASP Chip

Stephen Edwards Sponsor: Rodney Goodman

A design is presented for a processor which directly executes a high-level language, FORTH, utilizing a custom VLSI chip which performs arithmetic and stack operations. The processor is pipelined, uses a 32-bit data bus, and has a 16 megabyte address space. A discussion of the internal workings of the VLSI chip is presented along with a detailed description of the operation of the processor treated on an instruction-by-instruction basis.

Distributed Vision Processing Algorithms

David Emerson Sponsor: Rodney Goodman

My work was divided into two phases: tool development and algorithm development. The tool development phase consisted of writing software to display images on a Sun Workstation and output them on an Apple Laserwriter. This included the conversion of data from an image processor to the Sun rasterfile format and to the Postscript language. The algorithm development phase involved writing software to isolate individual handwritten alphanumeric characters from their background. Higher level routines which attempt to classify the characters will use the output of my routines as input.

Mapping the MoxE Gene of Methylobacterium AM1

Wen-Hsiu Fan Sponsor: Mary Lidstrom

Methylobacterium AM1 belongs to a group of bacteria called methylotrophs, which are unique in their ability to utilize one-carbon compounds like methanol. Mapping the MoxE gene would enable us to try to identify the function of the gene product in the methanol oxidation reaction. Besides one EcoR 1 site on the MoxE region, two restriction sites, Kpn 1 and Sst 1, have been mapped so far. At present, attempts are being made to create four types of subclones, two using the Kpn 1 site and two using the EcoR 1 site. These subclones will then be mated with MoxE mutants of the strain M. AM1 as a complementation test. Work will also continue to see if there are other restriction sites on the MoxE fragment.

Moire Pattern Ion Channeling Lithography

Robert Fox Sponsor: Harry Atwater, Jr.

Masked ion beam channeling lithography (MIBL) is an interesting technology, due to high data rates, short exposure times and good resolution relative to optical lithography. Dechanneling of ions and optical mask printing technology limit the resolution of this process to about 9.25 μ m.

This project explores a novel ion beam lithographic technique, "Moire pattern ion channeling lithography," which employs multiple superimposed single crystal membranes to generate a spatial modulation of the ion flux similar to an optically generated Moire pattern. The periodicity of the Moire pattern is adjustable and is potentially capable of pattern generation in the 10-250 Å regime. Such high resolution periodic patterns may find use in the fabrication of templates for crystal growth, x-ray optical components and quantum confined device structures.

Computer Control of a MBE Machine

Tracy Fu Sponsor: Thomas McGill

Molecular beam epitaxy (MBE) is a process used to grow atomic layers on a substrate with a great deal of precision. While its precision makes MBE very useful in making complicated structures, it also burdens the user with a lot of tedious work. My SURF project involves making the MBE machine easier to use by interfacing some of its components with computers.

Growth of InGaAs Quantum Well Lasers in V-Grooves

David Geraghty Sponsors: Amnon Yariv and Lars Eng

InGaAs quantum well lasers grown by single step MBE in v-grooves promise maximum current confinement and minimum effective hole mass. This should result in ultralow threshold current lasers. We are working towards growing these lasers and characterizing them by threshold current, threshold current density, quantum efficiency, and second quantized state lasing.

Cavitation Nucleus Injector

Eric Hassenzahl Sponsor: Allan Acosta

This SURF is to design and build a nucleus injector nozzle for use in the study of cavitation in the Low Turbulence Water Tunnel in the Keck Hydraulics Laboratory. Upstream of the test section, this nozzle releases a cloud of micro-air bubbles which expand in a region of very low pressure, then violently collapse, causing a process known as cavitation. The study of cavitation is useful because the collapse produces sound waves, and cavitation on or near a body can change the aerodynamic qualities of the surface and cause wear.

Characterization of Virus Transport Through Porous Media

Laura Hernandez Sponsor: Mary Lidstrom

Groundwater used for drinking and irrigation has been found to contain pathogenic viruses, bacteria, and other microorganisms released from various sewage sources. The development of mathematical models for characterizing virus transport through saturated porous media is essential for predicting sewage dispersal in groundwater aquifers. As part of ongoing research to characterize the transport of a model virus (bacteriophage lambda) through Ottawa sand, I have: 1) studied the stability of lambda under quiescent and turbulent conditions over a pH range from 4 to 11.2, 2) developed a protocol for studying the sorption of lambda to Ottawa sand that minimizes the production of unsettlable microparticles (colloids) and, 3) carried out a number of sorption experiments to determine the rate and extent of lambda sorption at pH values of 5 and 10.

Stabilization of Arcs in Electric Furnaces

Jay Higley Sponsors: Paul Bellan and Michael Brown

Large electric furnaces with currents of 10's to 100's of KA have been used for decades to melt down scrap steel. Unfortunately, the arcs in these furnaces suffer from instabilities which cause very large and damaging voltage spikes. This SURF was involved with building a singleshot atmospheric arc of roughly 5KA to simulate these electric furnaces. This small arc would then be used to test the effects of a coaxial magnetic field for stabilization of the arc.

The Relationship Between Cavitation and Nucleus Concentration

Dong-Su Kim Sponsor: Christopher Brennen

Cavitation is the explosive growth and collapse of vapor pockets during fluid flow in regions of pressure variation. For example, cavitation may occur during the operation of ship propellers, turbomachinery, and hydrofoils. Cavitation alters the performance of such devices. Furthermore, the catastrophic collapse of cavitation bubbles may cause surface damage as well as a sharp acoustic emission.

Low Turbulence Water Tunnel (LTWT) at Caltech was used to study the cavitation on a standard body and an in-line holography system was used to image cavitation events, and to determine the nuclei concentration in free stream flow. This research involved modification of a system, learning the photography and development techniques of holograms, reconstruction of holograms, nuclei counting, and of course the operation of the LTWT.

Molecular Dynamics Simulation of Low Energy Ion Bombardment

Howard Lee Sponsor: Harry Atwater

A three-dimensional molecular dynamics simulation has been written to study the effects of low energy (10-100 eV) ion bombardment of islands on a substrate. The atoms are assumed to interact through a Lennard-Jones potential. The depth of the collision cascades and the rate of propagation of energy from the impact point are measured. The adsorption and scattering of the incoming particles and sputtering of island or substrate atoms are observed in animation. The dependence of the mass and cohesive energy of the atoms on these effects is studied.

Photoelasticity and the Study of the Human Cornea

Kate Loomis

Sponsor: Wolfgang Knauss

It has long been known that the cornea in some animals (including man, rabbits, cats, and non-human primates) exhibits fringes under polarized light. If it can be proven that these fringes are a result of a stress-optic effect in the eye, a knowledge of the fringe pattern of the cornea would provide a non-destructive method for measuring stresses present in the eye. This knowledge would be especially significant in the further study of the effects of keratotomy, a surgical procedure to improve vision by placing cuts in the cornea. This research has attempted to 1) explain the birefringence phenomenon with respect to the spherical shape of the cornea, and 2) provide supporting evidence for the birefringence hypothesis.

Smoke-Wire Visualization of Air Entrainment in a Laminar Diffusion Flame

Raif Majeed Sponsor: Edward Zukoski

This project set out to study how air is entrained into a laminar buoyant diffusion flame, which is similar to most room fires. In the experimental procedure, a 1 mm stainless-steel wire is placed near a 19 cm porous-bed natural gas burner and coated with smoke-stack oil. Then, a moderate voltage (about 30V) is applied to the wire, causing the oil to emit a thin smoke. The intent of this project is to determine (quantitatively, if possible) how air is drawn into the flame by observing the smoke trails from the wire.



Carrier Lifetimes in A1.GA1.As

Kent Nordstrom Sponsor: Amnon Yariv

A novel method for time-resolved photoluminescence was used to determine radiative carrier lifetimes in $A1_xGa_{1-x}As$ materials at very high carrier densities $(10^{19}/\text{cm}^3 \text{ or more})$. Lifetimes depended strongly on the aluminum mole fraction, x, increasing as x increased. Lifetime also varied to an extent with excitation level, generally increasing with carrier density but eventually reaching a maximum and decreasing again near the limit of the experiment's excitation capability.

Studies of Shock Focusing for Extracorporeal Shock Wave

Barry Stipe Sponsor: Bradford Sturtevant

Extracorporeal shock wave lithotripsy (ESWL) has been developed over the past ten years to better treat patients with kidney stones. Fragmentation of stones with shock waves is now the treatment of choice among physicians, replacing surgery. Unfortunately, the technique has been known to cause tissue damage. Other health problems have also been linked to ESWL. Only by taking careful measurements of the stress field created by ESWL can one begin to discover the mechanisms of injury. My SURF dealt partly with the testing of the miniature pressure transducers used for such measurements. This was done with a piston-drop device. I also drew up plans and supervised the machining of an ellipsoidal reflector. This reflector is patterned after the Dornier HM4 lithotriptor commonly used in hospitals.

Investigations of the Effects of Damping Circuitry on the Stability of the Cuk Converter

Pei-bsiu Suen Sponsor: Slobodan Cuk

For the basic Cuk converter, the dutyratio-to-output transfer function calculated from a model of the converter has two right-half-plane zeros, which adversely affect the stability of the system. In order to move these zeros into the left-half-plane, an RC damping circuit is connected in parallel with the energy transfer capacitor. This project attempts to find a general solution for the optimum values of the resistance and the capacitance, as well as investigate the effects of other combinations of RC values on the overall stability of the converter feedback circuit.



Rendering of Polygons in Three Dimensions Using Multicomputers and a Distributed Database

Su-Lin Wu Sponsor: Charles Seitz

Graphics and imaging are timeconsuming tasks even for the fastest computers. However, multicomputers can process many parts of a picture at once. This multicomputer program computes the appearance of many different parts of a complicated image at once, producing a picture in a fraction of the time required by conventional computers. The program also translates, rotates, and scales images to help users visualize the structure of three-dimensional objects or scenes.

Experimental Projects in Control Theory

Richard Yeh Sponsor: John Doyle

The primary purpose of this project was to design and construct a mechanical device suitable for introductory undergraduate experiments in control theory. The plant consisted of a pointer with two degrees of freedom. A MASSCOMP unit controlled three servomotors which changed the orientation of the pointer. Two of the servomotors were used as controllers while the third was used to simulate noise. One example of the experiments run on this device was the stabilization of the two-dimensional inverted pendulum.

ABSTRACTS

Geological and Planetary Sciences

Thermal Model of the Interior of Mars

Seth Bittker Sponsor: David Stevenson

A thermal model of Mars was developed in which conduction carried heat through the crust and convection carried heat through deeper layers. Heat fluxes and layer thicknesses were obtained using Rayleigh number calculations in the boundary regions. Unlike previous work, the heat loss through volcanism was taken into account.

Tunable Far Infrared Laser Spectroscopy of the Water-Nitrogen Complex

Janet Bowen Sponsors: Bruce Murray and Geoffrey Blake

We have studied the water-nitrogen complex using tunable far infrared laser spectroscopy. The *b*-type, $\Delta K = 1$ transitions of the N2-H2O complex have been observed for P(14)-P(2), Q(1)-Q(14), and R(0)-R(7), originating in the K = 0 state. These transitions originate in the B1/B2 states of the complex. This data has been fit to obtain spectroscopic constants for the K = 1 state of the complex. Using a microwave spectrometer, the a-type, K = 0 transitions of the N₂-H₂O complex have been observed for the states originating in J = 3-9, adding to the work of Leung, et al. (1989). We have fit this data to determine spectroscopic constants for the K = 0 state.

The Structure of Triton

Amar Gandhi Sponsor: David Stevenson

It is believed that Triton formed in a heliocentric orbit and was captured into a highly eccentric retrograde orbit around Neptune. Tidal dissipation caused this orbit to evolve into its present-day circular orbit. The effect of this tidal heating on the thermal evolution of Triton's rocky core and the water-ice layer was investigated. Data from the Voyager 2 spacecraft revealed Triton's mass and density. This allowed us to resolve our models and address fundamental questions about Triton's origin and evolution. We also performed calculations to understand the behavior of methane and nitrogen on the surface. This will aid us in interpreting the surface features as seen on Triton's surface by Voyager 2.

Tunable Far-Infrared Laser Spectroscopy of the HCI Dimer

Janet Lai

Sponsor: Geoffrey Blake

High resolution spectra of the ground state $K_a = 0(u) \rightarrow 0(g)$ a-type rotational-tunneling transitions of (H³³Cl)₂,H³⁷Cl)₂, and H³⁵Cl-H³⁷Cl have been observed near 15.5 cm⁻¹ using a tunable far-infrared laser spectrometer. The data has been rotationally analyzed to yield rotational constants and tunneling splittings for the three hydrogen chloride dimers. Also, the quadrupole hyperfine structure from the chlorine nuclei has been resolved and analyzed.

Honeybees' Response to Alternating Magnetic Fields

Alfredo Morales

Sponsor: Joseph Kirschvink

Animal Magnetism: Is it real? Historically, one of the most controversial topics in biology concerns the effects of weak electromagnetic fields on living organisms. Recently, work at Caltech and in Hawaii has shown that honeybees can be trained to detect weak anomalies in the geomagnetic field.

ABSTRACTS

Humanities and Social Sciences

These experiments are simple to replicate yet yield by far the clearest magnetically-influenced response yet found in an animal. We are now conducting experiments to test the response of bees to low frequency alternating fields, and have demonstrated sensitivity to 1, 10, 30, 60, and 100 Hz fields.

Magnetostratigraphy of Plio-Pleistocene Lake Manix Sediments

Christopher Pluhar Sponsor: Joseph Kirschvink

Previous age constraints of Plio-Pleistocene Lake Manix have been improved by magnetostratigraphic study of the area. Paleomagnetic samples indicate an epoch of normal magnetic polarity bounded by older and younger epochs of reversed magnetic polarity. From previous dating of a volcanic ash (2.0 million years old – Huckleberry Ridge ash) in the section and the two reversals the normal chron would be the Olduvai normal epoch (1.72–1.88 million years ago) and the extrapolated deposition rate would be between 123 and 245 years per centimeter.

Far-Infrared Laser Spectroscopy

David Risher Sponser: Dr. Geoffrey Blake

A tunable far-infrared (FIR) laser spectrometer has been constructed to be used for FIR spectroscopy of Van der Waals and hydrogen bonded clusters in a supersonic jet. The output of a CO2 laser is used to stimulate a gaseous molecule into an excited vibrational state which then lases at a fixed frequency between two adjacent rotational levels. The FIR laser is then mixed with a 0.01-20 GHz microwave source, supplemented by frequency multipliers and amplifiers, in a GaAs Shottky barrier diode to produce tunable laser sidebands at \pm 0.01-80 GHz from the FIR laser output.

Modelling of the H₂ Ultraviolet Emission Spectrum

Craig Sosin

Sponsor: Ewine van Dishoeck

Using new, more accurate electronic potential curves and dipole moments, we have computed improved values for the bound-bound and boundcontinuum transition probabilities of the Lyman and Werner systems of H2. Corrections to earlier values become more significant for higher vibrational states. We have applied this new data to a computation of the theoretical ultraviolet spectrum of a typical interstellar cloud, such as IC 63. Our spectrum compares favorably to observed spectra, and contains lines that cannot be explained with bound-bound transitions only.

The Building of a Fourier Transform Ultraviolet Spectrometer

Xiaolei Zhu Sponsor: Yuk Yung

OH is an important molecule in tropospheric chemistry, cometary atmosphere, and is involved in the ozone catalytic chemistry in the stratosphere. Dr. Stanley Sander (JPL) has been developing a Fourier Transform Ultraviolet Spectrometer which can detect OH transitions. The OH UV spectrum in the terrestrial atmosphere has been synthesized and the emission rate factors of OH (gvalues) have been calculated. The results will be used to retrieve OH abundances from Dr. Sander's observations.

A Look at Colloquial Professional Naming Conventions and Gender Assumptions

Tien-Yee Chiu

This project attempted to evaluate Robin Lakoff's 1973 claim that under the conventions for spoken references to colleagues, women are systematically relegated to the ranks of the less well known; it also examined default gender assumptions from names nonindicative of gender. The data showed no difference between terms of reference for males and for females, and actually showed that in cases where one researcher is more prominent than the other, the more prominent one was assumed to be female.

SURFing in Windhoek

Samuel Clark Sponsor: Edwin Munger

Under the sponsorship of Dr. Ned Munger, Gary Bloomberg, a Caltech graduate student and I spent eight weeks this summer teaching mathematics and physics at the University of Namibia, Windhoek. I taught a first year calculus course and half of a second year math course.

We were challenged by the fact that the education system in Namibia generally produces ill prepared, nonmotivated students, and that the university nonetheless maintains rigorous standards. It was interesting, and at times frustrating, working through these problems, especially trying to raise the level of motivation in our students.

It is a very exciting time in Namibia as the nation prepares to receive its independence in November. Naturally the foreign culture and people kept us busy trying to adapt and understand, and we did some travelling and had some very enlightening discussions with local people.

Industrial Relations in Southern California, 1944-80: A Study of Employee Opinion Polls

David Edwards and Jackie Holmes Sponsor: Doug Flamming

This report analyzes employee opinion polls taken by Caltech's Industrial Relations Center between 1944 and 1980. The responses were coded into a spreadsheet and analyzed using a statistical software package. Using these programs, we will determine the relative levels of satisfaction in various industries, the importance of sexual integration in the workplace, and the relative satisfaction of workers with different levels of seniority. Most importantly, we will analyze the change of employee opinions over time, in the hopes of analyzing how the socioeconomic and political climates of the day affected employee satisfaction.

Voting Patterns in the California State Assembly

Stephen Hwan Sponsor: Bruce Cain

For years the California State Legislature has been stalemated and has had trouble getting significant legislation passed. This has been shown in the need to put 29 initiatives on the November 1988 ballot. I have been examining a sample of roll call votes of selected years to look for voting patterns in the California assembly.

How Do You Spell Relief? An Analysis of Baseball Pitching, 1876 to Present

Ari Kaplan Sponsor: D. Roderick Kiewiet

The history of baseball is rich with traditions. However, many aspects of the game have changed, including rules and strategies of playing. Perhaps the most peculiar change in the game is the role of pitchers. Although the rules governing pitchers remained almost constant over the last hundred years, the use of pitchers, especially relief pitchers, has changed dramatically. We analyzed the ways the roles of pitchers have changed in major league baseball, including the relationships of the number of pitchers per team, the number of complete games, the number of total games, and the percent of relief appearances, among many other factors, since the beginnings of baseball. In addition, a new statistic was developed to better describe relief pitchers, which focuses on their ability to keep inherited runners from scoring. A baseball statistic program was written to enter and analyze data for today's teams. With this SURF, the changing roles of pitchers were clarified and explained to some extent.

How to Price a Car

Scott Kister Sponsor: Charles Plott

I am developing a competitive pricing model that can test car pricing strategies, such as incentives and rebates, in a competitive environment. The model is an interactive simulation, in which users, representing GM, and other domestic and imports are linked through a computer.

The benefits from the model are its ability to generate insights about the short- and long-term sensitivity of inventories, market shares, and profits to different pricing incentive strategies.

ABSTRACTS

Physics, Mathematics and Astronomy

An Analysis of Aid To Families With Dependent Children Fraud

Ashoke "Bappa" Mukherji Sponsor: Louis Wilde

Politicians have debated the efficacy of federal welfare programs since their inception. The largest incomemaintenance program in the United States is Aid to Families with Dependent Children (AFDC).

A great deal of literature exists regarding the welfare program; however, econometric studies have yet to analyze fraud in the system. After creating a database containing welfare specific and social variables, we conducted cross-sectional time series regressions to determine the best administrative methods to reduce the amount of fraud in the system.

The Male Life Course in Rural Liaoning, 1774-1873

Chris Myers Sponsor: James Lee

In this paper, we analyze the male life course for 8,000 Chinese peasants, in particular their passage from adolescence to adulthood, and their transition from adulthood to old age. Our focus is on determining, on the one hand, the timing and ordering of such events as coming of age, marriage, and retirement; and measuring, on the other hand, the intersection of the life course with local social structure. We conclude that while social structure had considerable influence over the probability and timing of achieving these events, there was also a significant number of deviations from the standard life course which were a product of luck.

Electrical Technology in Rural Areas of India

Chandra Raman Sponsors: Jeffrey Dubin and Thayer Scudder

Electricity is vital for irrigation in India's Tamil Nadu state. To provide connections and maintenance services, a cooperative scheme has been established to cover small areas. The administration is local and thus more effective. Yet, heavy line losses and government subsidies remain hindrances to the economic viability of the cooperative.

An Application of Case Grammar to a Computational Linguistic System

Erich Schneider Sponsor: Bozena Thompson

Case grammar is a linguistic theory which studies the structure of sentences through the "cases" of their nouns; these cases being certain transformationally invariant roles played by the nouns. The application of this theory to noun phrases facilitates the creation of a new object in a computer language understanding system, the "action noun"; this object allows the user to access computer procedures in a more intuitive way.

Generating Error-Correcting Codes

Huy Cao Sponsor: Heeralal Janwa

The purpose of the summer project was to examine known values of covering radii and minimum distances for error-correcting codes, and to try to improve them. Toward this goal, programs were developed to work with polynomials in finite fields. New errorcorrecting codes were then found with the aid of the programming tools, and data from these new codes were then checked against known results to see if improvements had been made. Possible future improvements to these programs might include refining the algorithms for speed and memory efficiency, and implementing them on concurrent machines so that they can be used for larger codes.

A Search for ²H, ³H, and ³He in Large Solar Flares

Mike Chou Sponsor: Richard Mewaldt

The rare isotopes ²H, ³H, and ³He can be produced by nuclear interactions when 'H and 'He are accelerated in the solar atmosphere during solar flares. Solar energetic particle data collected from 1980 to 1988 by the Caltech Electron/Isotope Spectrometer on the satellite IMP-8 was analyzed to yield the relative abundance ratios ²H/¹H, ³H/¹H, and ³He/⁴He. A total of approximately \geq 105 hydrogen events were analyzed. Because there is no evidence for finite flux of ²H or ³H, we place an upper limit of $\sim 10^{-3}$ on the ratios ²H/¹H (9 - 19 MeV/nuc) and ³H/¹H (7 - 15 MeV/nuc). A finite flux of 'He was observed, and the ratio ³He/⁴He (15 - 30 MeV/nuc) is estimated to be $(7 \pm 3) \times 10^{-3}$. From the above data, we conclude that solar flare nuclei have suffered no significant fragmentation before escaping from the sun.

Measurement of Transverse Solar Magnetic Fields

Glenn Eychaner Sponsor: Harold Zirin

Since all solar activity seems to be controlled by magnetic fields, it is necessary to be able to measure vector magnetic fields on the sun in order to understand the formation, evolution, and decay of solar phenomena. Big Bear Solar Observatory has long been measuring the longitudinal component of regional magnetic fields, which is oriented along the line of sight. This longitudinal field, however, is not the entire magnetic field. Many solar events, such as flares, also involve the transverse component of the regional magnetic field, which is oriented perpendicular to the line of sight. In order to evaluate the total vector magnetic field of solar regions, I have been developing a system for measuring the transverse magnetic component of these regional fields. In this way a much clearer picture of how magnetic fields drive solar phenomena can be obtained.

Constructing VLA Maps of Microwave Sources

Varoujan Gorjian Sponsor: Anthony Readhead

I used data from the Very Large Array (VLA) to construct radio images at two frequencies, 1.4 GHz and 5 GHz, of an area around the celestial North Pole. The maps will be used to find areas free of strong radio sources to be used for observations of the microwave background radiation.

Topological Spaces

Li Wen Ho Sponsor: W.A.J. Luxemberg

The notion of a paracompact topological space is usually characterized in terms of coverings as follows: every open covering of the space admits a locally finite open refinement. We came up with an alternative characterization in terms of filters. Using our new characterization of paracompactness, we then worked on proving certain wellknown results on paracompactness.

We also studied the properties responsible for a topological space to have the Baire property. In our study, various applications of the Baire Category Theorem were looked at.

Quantum Mechanical Calculation of Momentum Distribution Inside a Nucleus

Jinha Kim

Sponsor: Bradley Filippone

One can test the effect of color transparency predicted by Q.C.D. if the momentum distribution of the protons inside a nucleus is known accurately. With this purpose, a program was written to calculate a normalized quantum mechanical momentum distribution of protons inside the nucleus assuming a shell structure of the nucleus.

First, the program was written using a central potential of infinite spherical well which is a good approximation for low A's and then, it was modified to calculate the momentum distribution of protons in a potential well of finite depth.

High Energy Irradiation of VO2

Keana Kim Sponsor: Thomas Tombrello, Jr.

A conductor has faster deexcitation mechanisms that can dissipate kinetic energy transferred from projectile ions to target atoms than a semiconductor. Thus, VO₂ sputtering yields at high temperatures (T > 68°C) are less than at lower temperatures (T < 68°C) because VO₂ goes through a phase transition from metal to semiconductor at temperatures below T = 68°C. Using the same argument, we can expect that VO₂ at higher temperatures will have less structural damage when irradiated with 25 MeV Cl³⁺ ion beams than at temperatures below 68°C.

When VO₂ is irradiated while it is in its metal phase (T > 68°C), the resistivity measurements taken at temperatures above the transition temperature (T₁) show very little deviation from the resistivity measurements of pristine regions at the same temperature. But when VO₂ is irradiated while it is in semiconductor phase (T < 68°C), the resistivity measurements show that there is more structural damage done than in the hot irradiation of VO₂.

Determination of the Temperature Coefficient of Conductivity for Random Graphite Grains in Amorphous Carbon

Anita Lee

Sponsor: Thomas Tombrello, Jr.

When irradiated by a high-energy ion beam, amorphous carbon will become more electrically conducting. This process depends on a number of factors including the temperature of the carbon sample and the type of ion in the ion beam. Several mathematical models have been suggested for the conduction process. The models have been tested by fitting data obtained from irradiation by oxygen ions.

Quantitative Comparison of Two Neutrino Detector Geometries Using Monte Carlo Techniques

Steven Ludtke Sponsor: Felix Boehm

Neutrino detection relies on the capture of photons generated in two small light flashes, which are caused by neutrino capture in scintillator doped water. Since relatively few photons (~5000) are generated by one of these flashes, it is important to design the detector to collect as much information from the photons as possible. There are two geometries commonly used to accomplish this. The first geometry uses a single large cubic tank of water (10m \times 10m \times 10m) with pho-

Oxidation Kinetics of Bi₂SrCaCu_{1.35}O_x

Yvonne Lung Sponsor R.M. Housley

Bi2SrCaCu1.35Ox is the nominal composition used as the melt to crystallize thin films of the 31-angstrom phase high-Tc superconductor, Bi2Sr2CaCu2O8, on MgO ceramic substrates. My project was to study the oxidation kinetics of Bi2SrCaCu1.35Ox. A thermogravimetric analyzer (TGA) was used to measure the weight loss percentage of Bi2SrCaCu1.35Ox samples as they were heated under different atmospheres beyond their melting points. The result shows that the oxygen content of the sample, which determines the melting point, the electrical properties, and the critical temperature (T_c) of the superconductor is dependent upon the composition of the atmosphere. The results, thus, suggests the optimal oxidation treatment to be used during the crystallization of Bi2St2CaCu2O8.

totubes on all 6 faces. The other uses several long, narrow rectangular tanks $(25 \text{cm} \times 75 \text{cm} \times 10 \text{m})$ with phototubes on the 2 small faces and with the 4 long faces coated on the inside with teflon or a thin layer of air. In the first scheme, light is collected directly from the event. In the second case, due to total internal reflection, the teflon (or air) makes 4 of the 6 walls reflective to photons incident to the surface over a wide range of angles. This allows a large percentage of the photons generated to bounce their way down the detector and eventually be captured by the phototubes at both ends.

Each of these geometries has qualitative advantages and disadvantages, and it was desired to make quantitative comparison of the merits of both schemes. To do this, a realistic simulation of each detector was developed. Then by simulating large numbers of neutrino events in each detector, various important parameters, such as total percentage of light collected, timing smear of the arriving photons, and localization of reconstructed events, were compared.

Potts Cluster Demonstration Program

Bao Quoc Pham Sponsor: Clive Baillie

My summer project is a Sunview-based demonstration program for the Potts model. The demonstration program allows two to four different spin states. The user interface for the program is object-based, making use of Sunview's window and object handling features. Four different algorithms are currently supported: the basic Monte-Carlo, the Wolfe cluster algorithm, the anticluster algorithm, and the self-labeling algorithm. Each individual algorithm can be accessed from a panel of buttons. Another button gives the user access to a configuration menu where simulation
parameters can be adjusted. The main control panel is hidden once the simulation is initiated so the entire screen can be used as the display area, facilitating video production of the desired simulation sequence.

Problems in Combinatorial Graph Theory

Steven Rosenberg Sponsor: Richard M. Wilson

Conditions for Hamiltonicity and for perfect matchings to exist in certain combinatorial graphs were investigated. The n-cube, H(n), is the graph whose vertices are all the binary numbers of length n bits, with two vertices adjacent when they differ in exactly one bit. The graph B(k) is the subgraph of H(2k + 1) induced by the vertices which have k or k + 1 ones. I found a direct decomposition of B(k) into perfect matchings, and found what conditions on the number of times each direction is used are necessary and sufficient to guarantee the existence of a perfect matching in an n-cube. A set of necessary conditions has been proved for the analogous problem with Hamiltonian circuits in an n-cube, but whether they are sufficient is still unknown. I also found simple Hamiltonian decompositions of the product of two cycles each of length at least three.

BaF2 Scintillator and Light Readout System

Pongskorn Saipetch Sponsor: Harvey Newman

I investigated light output and radiation resistance of BaF₂. UV sensitive photomultiplier tubes and a spectrophotometer were used to make measurements before and after 1 Mrad gamma rays from Co-60 radiated the BaF₂ crystals. The possibility of using UV-sensitive photodiodes with wavelength-selective filter as a light readout system was also explored.

We found that La-doped BaF_2 was radiation hard and gave a high proportion (50%) of fast light (scintillation with short decay time). Pb contamination caused very strong absorption at around 200 nm and should be eliminated.

Genus G Systems and the Mathieu Groups

Dylan SeLegue Sponsor: Michael Aschbacher

A genus g system is a transitive group of permutations which satisfy a few special hypotheses. These hypotheses come from problems involving field extensions and coverings of Riemann surfaces. The intent of this SURF is to analyze the Mathieu groups and determine the number of ways these groups can be realized as genus g systems.

Tools for the Analysis of Muon Time Series

Mike Smyth Sponsor: Barry Barish

Cosmic rays are an important source of astronomical information. A good way to understand cosmic rays is to examine the muons that they generate. What sort of problems are encountered in the analysis of muon time series, and what can be done to overcome these problems? This question is answered, and the tools developed are applied to recently collected data.

Packings and Coverings in Graded Posets

Glenn Tesler Sponsor: Richard M. Wilson

Paul Turán determined the maximum number of edges a graph on n vertices can have without having a complete subgraph on p vertices, and then posed the still unsolved generalization of this question to hypergraphs. I further generalize this question to: What is the extreme size of a collection of chains with elements of ranks r1,...,rkin a graded poset **P** so that every chain with elements of ranks p1,...,pl can be extended by at least/at most λ chains in the collection?

Extremal values for different posets and different values of the parameters are related to each other, and specific applications of the general results to hypergraphs and multidimensional cubes and octahedra are explored.



ABSTRACTS

Computation and Neural Systems

A Study of the Scintillation Tank's Optics in the Macro Detector

Ki Ching Wong Sponsor: Barry Barish

The scintillation counters for the Macro detector are the major component of the detector. Therefore, a thorough understanding of the tank's optical response characteristics is necessary. Studies have already been made on the tank response to a far-field event, but the response of near-field events was not very well understood. According to a preliminary investigation by Stephane Coutu, a central "hotspot" develops when the scintillations (simulated by ultraviolet point-source) occurred in close range of the photomultiplier tubes < 25 cm). However, after further investigation into the cause for such a "hotspot", I discovered that the main reason for the hotspot to develop is the asymmetry of the construction of the tank itself. The presence of a drain pipe had caused a much lower response of the phototube, which would manifest itself as a "hotspot" when the data were symmetrized.

Precise Calibration of CaF₂ Target for Superconducting Supercollider

Xiaojian Yan Sponsor: Harvey Newman

To calibrate the electromagnetic calorimeter at SSC (Superconducting supercollider) energy level, we need a clean, fast, stable, precise and high energy γ ray source. This is achieved by RFQ technique. In this experiment, I bombarded 4 Mev Proton beam on CaF₂ target, giving out electromagnetic equivalent energy deposited in each crystal up to 40 TeV. This experiment also shows low neutron background and uniform γ ray angular distribution. The off-line data analysis have been done with the help of the Monte Carlo method. The result agrees with previous estimation and calculation of the Monte Carlo simulation.

Temporal Coherence and Oscillations in the Visual Cortex

Brian Brandt Sponsor: Daniel Kammen

Recent studies have shown that the firing probability of neurons in the visual cortex oscillates at a peak frequency near 40Hz in response to optimal visual stimuli. In addition, the phase delay between cells tuned to the same orientation but several hypercolumns apart is less than three milliseconds. Temporal synchronization of neuronal activity has been suggested as an information processing strategy with a number of advantages over static, or steady state, algorithms. The rapid synchronization in the firing patterns of neurons provides an attractive mechanism for object oriented information processing. It has therefore been proposed that temporal synchronization plays a role in attention and figure/ground segregation of visual scenes. Using GENE-SIS (general neural network system, developed here at Caltech), we have simulated a large number of small (two to four cells) neural circuits. We have found that a synchronized oscillatory repose is produced in networks having a common inhibitory feedback pathway, and have mapped the behavior of these networks within a large parameter space.

A Model for Direction Selectivity and Velocity Tuning in Visual Cortical Cells

Gary Holt Sponsor: Christof Koch

Direction selectivity and velocity tuning of visual cortical cells may be due to "feedforward" circuitry, which spreads the activity from one point in the receptive field to nearby points. A model of this was formulated analytically and tested by simulation. The spatial structure of receptive fields was described by Gabor functions; temporal properties were modelled as lowpass filters. The model was tested with narrow moving bars and found to give realistic responses. Both velocity lowpass and velocity-tuned (DS1) cells are produced, and the shape of the direction tuning curve changes properly as bar length is decreased.

Hebbian Learning in a Computer Vision System

Johnny Ng Sponsor: Daniel Kammen

A real-time computer vision system is under development that employs adaptive filtering and Hebbian learning to efficiently and accurately predict scenes and to construct a dynamic object table for navigation purposes. Scenes are first filtered through Gabor functions, since they are reasonable approximations of biological receptive fields. The scenes are then segmented using cluster analysis to produce an object map. A new frame is predicted based on this object map, and the accuracy of this prediction, along with other sensory data, will alter subsequent filtering and segmentation parameters to produce a more accurate picture of the world. This vision system will be developed and tested in conjunction with the JPL Robotics Laboratory autonomous land vehicle navigation package.

Passive Autofocus and Ranging for Artificial Retinas

William Rogers Sponsor: Christof Koch

Researchers in Professor Christof Koch's and Professor Carver Mead's labs are using custom analog VLSI vision chips, inspired by biological models of the retina, for navigation of small robots. These chips replace the commercial autofocus cameras typically used, but lack the autofocus capability. My project was to build an autofocus device for these artificial retinas. Instead of starting from scratch, I modified a 35 mm autofocus camera to fit this application. The camera chosen uses a passive focusing mechanism. A secondary objective was to obtain distance-to-image information from the focusing mechanism.

Putting Theories Back on Course: Implementation of the Neural Net Based Speech Recognizer

Peyjen Wu

Sponsor: John Hopfield and Douglas Kerns

The objective of the project was to design and implement a 16-channel neural net based speech recognizer. It has been simulated within the idealized world of the computer. Now, we need to go from "idealized mathematical hardware" to a real physical neural net to best evaluate the theories and to implement the most time-consuming and computation intensive part of the system. The education SURF provides is a different experience from that of the classroom: research problems don't have answers nicely bundled up in textbooks.

Concept, Analysis, and Design of a BCD for Mariner Mark II Spacecraft

Amin Abid Sponsor: John Klein

First, some general results about power converters are proved, and used as guidelines to arrive at a topology. The choice is confirmed using the recent work of Maksimovic. Second, a modification is made to include zero input and output ripple. The topology is then analysed and a time domain control scheme is used to design a high reliability BCD.

MicroMITE Satellite Antenna System Design and Analysis

Syed Zubair Ahmad Sponsors: Robert Clauss and Edward C. Posner

The purpose of this antenna is to provide a 360-degree coverage. The job can be done if two antennas, which give hemispherical coverage, are used. Modifications were done to the old design, and the new design gave a broader coverage. To "optimize" the radiation pattern, different procedures were done using just one antenna. A smooth pattern was obtained which was 6-7 dB down at 90 degrees and close to 0 dB at the boresight. A model of the spacecraft was built and the overlapping radiation patterns were taken by placing antennas in the diagonally opposite corners of the 12-inch cubic box. This configuration leaves more space for the solar cells on the outer surface of the box. A theoretical analysis was also done to predict the radiation pattern of the two antennas by using the data of a single antenna.

Acquisition and Tracking For a Deep-Space Laser Communication System

John Apostolopoulos Sponsor: James Lesh

The next generation of deep-space probes may use an optical communication link to communicate with the Earth. In order to study this possibility, the integrated optical communication test bench (IOCTB) was created at JPL. One of optical communications' great advantages, the ability to tightly focus the transmitted energy, results in the need to have great accuracy in the acquisition and tracking (acq/track) of the target for transmission and reception. I analyzed the acq/track system of the IOCTB, modified its acquisition algorithm and made it operational. I characterized and modeled each element in the system and found how each limited the performance of the overall system. I began to study the noise produced by each element and attempted to include this in an overall model of the system.

The Effects of Temporal Delay on Multigigabit/sec Coherent Fiber Optic Network Systems

Sophia Asghar Sponsor: Larry Bergman

Throughput in coherent fiber optic networks is limited by temporal delay during signal propagation and transmission. The effects of laser linewidth and optical fiber waveguide parameters-chromatic dispersion, group delay, mode phase shift, attenuation and polarization fluctuation-are characterized for transmission over long fiber distances. An interferometric method of measuring the coherence of a fiber optic system is proposed. It is shown that coherent optical fiber transmission technology employing spectrum spreading has conceivable applications to real time networks.

Nonequilibrium Chemistry Modeling of the Methane and Ammonia Abundances of Halley's Comet and Other Important Comets

Brett Bochner Sponsor: Mark Allen

We have utilized a nonequilibrium chemistry program to model the spatial distributions of CH and NH2 in various cometary atmospheres. By fitting the curvature and scaling of these calculations to observational data we may derive more accurate methane and ammonia production rates for the various comets in our investigation than previously possible. Most of this data has already been modeled with the older and simpler Haser Model, but the model we have used is superior for complicated chemistries like that of methane. Also at our disposal were better data sets, more specific information about solar fluxes during the dates of observation, and more reliable photodissociation rate constants for CH and NH2.

Plan for Task Scheduling and Resource Allocation

Mary C. Bullington and N. Scott Rafer Sponsors: William Whitney and Martin Leipold

The problem addressed is the scheduling and allocation of scarce resources in a dynamic manner and the tracking of these schedules and allocations over time. A software system has been designed to schedule and allocate flight-instrument facilities in the Observational Instruments Laboratory (OIL), to test the validity and consistency of such allocations against preimposed constraints, and to maintain an historic database of the previous allocations. Although the tool was created specifically for OIL, this approach and the software may be applied to other scheduling and allocation problems as well. The functional architecture of the system has been fully specified and the software has been implemented sufficiently to make the general concept clear. The code needed to complete the system may be implemented by other personnel.

Measurement of the Light Scattering Properties of Icy Planetary Surfaces

Herb Burrows Sponsor: Bonnie Buratti

The spectrogoniometer at the Jet Propulsion Laboratory is a detector system which measures the directional light scattering properties of geologic samples that are likely analogues of planetary surfaces. The spectrogoniometer was modified to do light scattering experiments on various frosts by adding a small vacuum chamber capable of accepting water vapor combined with geologic "dust" to produce frost samples up to 6 mm thick enclosed in a vacuum of milliTORR range created by a cryogenic absorption pump and cooled by liquid nitrogen at 77 kelvin. Using a large vacuum chamber cooled by liquid helium, I assisted the Voyager science team in obtaining the first ultraviolet spectra of methane frost at 30 kelvin, and separately of nitrogen frost at 40 kelvin. The ultraviolet spectrum of methane agrees with the photopolarimeter science team's measurement of the ultraviolet albedo (reflectivity) of Triton which confirms ground-based infrared measurements indicating the existence of methane on Triton.

Solid CO Abundance in Young Stellar Objects

Chris Campo Sponsor: Mark Allen

High resolution (0.057cm-1) spectra have been obtained for 15 infrared sources, most of them young stellar objects. Absorption lines are present in the spectra due to the presence of solid and gaseous CO. In the past, lower resolution observations have vielded imprecise estimates of the amount of solid CO present because gas features were not able to be separated from solid features at the low resolution. By examining the high resolution data and filtering out the gaseous absorption features, it will be shown that a more precise upper limit for the amount of solid CO present can be set.

Laser Counter for the Mark IV Stellar Interferometer

Robert Chang Sponsor: James Breckinridge

The laser counter is an integral part of a Michelson Stellar interferometer. It is used to count the number of fringe shifts that result from the change in optical path in the interferometer. The laser counter, then, is a sophisticated electronic counter that has as its output the phase difference between an unknown and a reference signal. My project has been to design the circuit and implement it on an erasable programmable logic device.

Sensor Modelling for Automotive Applications

Kevin Chase Sponsor: Jonas Zmuidzinas

A short review of automobile sensors and their principles of operation is given. From this, physical models for the sensors' responses are developed, which include nonlinearities, temperature dependencies, and response times. The models are then simplified to make mathematical analysis possible, and analytic expressions are derived. These models approximate the sensor response very well, and predict general sensor behavior over a wide range. Application of the models to a real-time computer simulation of a fault-tolerant engine control system is discussed.

MicroMITE Satellite

John Chen

Sponsors: Robert Clauss and Edward C. Posner

uMITES (Microwave Microwatt Interferometry and Telemetry Experiment Satellite) is the acronym of the project that I am involved with. The goal of this project is to build an experimental satellite that will transmit downlink tones at X(8.45 GHz) and Ka-band (32 GHz) carrier frequencies in order to perform VLBI (very long baseline interferometry) and telemetry experiments. In the two previous years of this project, preliminary design considerations and some initial designs of the subsystems were produced. Also, some hardware was built (such as the antenna). In this third year of our project, we hope to realize, either on paper or in actual hardware prototypes, the other various components that make up the subsystems of our satellite, based on finalized subsystem designs that we decide upon. My project this year continues and, as it turns

out, modifies the work done on the design phase of the transmitter subsystem. Also, I am building and acquiring the hardware necessary for various components of this subsystem.

The Characterization of a Free-Expansion Dust Gun

Phil Collins

Sponsor: Gregory Bearman and James Bradley

The purpose of this project was to characterize the operation of a high velocity dust generator and determine whether its free expansion design would be satisfactory for its planned use. We found that selected sections of the accelerated dust beam had velocity distributions between 180 and 110 meters/second. This velocity range was narrow enough for our purposes.

The VME Bus-Photon Camera Interface

Christiana Goh Sponsor: Mike Shao

The VME Bus-Photon Camera interface board will accept TTL compatible data from a photon camera and store this data, to be retrieved at any later time by the VME Bus. The data will include eighteen bits of coordinate information and an activity strobe. The coordinate information will be stored in two 2048 × 9 bit FIFOs. Statistical information regarding the rate of activity and/or the amount of information in the FI-FOs will be monitored by an event counter. The board will operate as a VME A16/D16 slave, answering to six sixteen bit addresses, and engaging in a sixteen bit data transfer. The six addresses will call six different functions of the board: XY coordinate information, the ninth bits of XY coordinate information, counter information, clear signal for the whole board, and on/off signals to the self-test generator.

Programming for Robot Control System and Analysis

Roman Gutierrez Sponsor: Guillermo Rodriguez

One of the fundamental problems in moving robotic arms is what is referred to as inverse kinematics, where the objective is to determine the joint angle motions required for the arm to move to a prescribed location. Using algorithms based on state estimation theory developed at JPL, the movement of a robot arm restricted to move in two dimensions was studied. A simulation to model the motion and the forces involved in executing a surface polishing task were implemented. This simulation has the advantage of being expandable to model irregularities such as friction or flexibility of materials.

Numerical Model Simulation of Large Scale Ocean Circulation

Saeed Jaffer Sponsor: David Halpern

With variables such as "anomaly of dynamic height" and "specific volume,' physical oceanographers describe the ocean's current and movement accurately. Simple temperature, pressure, and salt-content (salinity) data of the ocean supplies the desired variables. Presently, there is a numerical model that supplies this data over a large area of the Pacific Ocean. My assignment was to test the model for its accuracy concerning the dynamic height variable. Since the calculations involved are so complex, I created a computer software package to find the anomaly of dynamic height according to the model's salinity and temperature data.

Fault Tolerant Sensors

Sandeep Jain Sponsor: Jonas Zmuidzinas

Sensors measuring different parameters of an engine are prone to failure. We explore algorithms for setting up fault tolerant sensor systems using hardware and analytic redundancy.

As an application, a simple redundancy scheme is developed for sensor fault tolerance in a car engine. Also, a mass air flow sensor etched on a silicon chip is considered which uses multiply redundant pressure, temperature, and velocity transducers to calculate air mass flow past a cross-section of a tube, and compensate for manufacturing errors or faults due to degradation.

Lightcurves and Pole Solutions for 1036 Ganymed

Lauren Jones Sponsor: Alan Harris

Photoelectric light curves of 1036 Ganymed were obtained during May-August 1989. Because this apparition was in a different part of the sky than in 1985, it was hoped that data collected during this time could help to solve for a pole position. The data set from June-December 1985 recently published by Hahn et al. (1989) was used along with our data to attempt solutions for the pole. The method for finding the pole solution was taken from Magnusson (1986); it is called the Epoch Method. Unfortunately, several statistically "good" solutions were found, so the pole orientation was not uniquely determined.

The Effect of Environmental Stress on the Performance of Q-Switched, Diode Laser Pumped Nd: YLF Ring Laser

Anthony Kewitsch Sponsor: James Lesh

A free-space laser communications system demands a high level of durability under the severe thermal, acoustic, and radiation environment of a deep-space planetary mission. To safeguard against in-flight failure, the laser performance must be characterized before and after environmental tests. Characteristics such as the peak power, average power, pulse width, timing jitter, and energy per pulse are critical in a direct detection laser transmitter utilizing pulse position modulation (PPM) and have been measured. In the future, the laser performance following vibration and thermal stress will be measured and any degradation in performance may be determined.

Near-Infrared Analysis of Stratospheric Aerosols on Jupiter

Tara Kirby Sponsor: Kevin Baines

Near-infrared maps of Jupiter's southern hemisphere acquired in 1985 at the Infrared Telescope Facility show that significant near-infrared opacity exists over the polar regions and Jupiter's Great Red Spot. Preliminary analysis has shown that this opacity is due to a relatively high concentration of stratospheric aerosols in these regions. A data set was prepared from these maps for comparison with atmospheric models. Thus, the accuracy of previous predictions about the origin and structure of these stratospheric aerosols can be determined. Also, various computer programs to be used in the preparation and analysis of the data set were adapted for use on the Unix operating system. The next step in this analysis will be to create atmospheric models that account for the observations in the data set.

Applications of UV Astronomy

Mark Lakata, Miguel McDonald, M. Alex Santoso, Blake Sullivan, David Townsend, Adam Weissman Sponsor: Arthur Lane

Our group was involved in several projects involving ultraviolet observation and spectroscopy in near-UV wavelengths. These activities were focused into three main areas.

Although much work has been done in the field of remote sensing with the infrared and visible wavelengths of light, little has been done with ultraviolet light. In order to determine if there is a practical or scientific value in using UV for remote sensing, two UV cameras were used; one stationed on the Delta Star satellite, and the other installed in NASA's C-130 earth survey aircraft. Two members of our group were involved in the aircraft flights directly, while others were responsible for handling the telemetry data from Delta Star.

Another project involved the determination of atmospheric transparency (in UV wavelengths) at the Table Mountain Observatory. Stellar spectra at UV frequencies were compiled for use in later observations to be made at the site. Using results from ultraviolet study of the selected stars, information about the composition of the atmosphere in the area will be obtained.

The third major project was providing support to the PPS group during the Voyager encounter with Neptune. The PPS (for photopolarimetry system) is one of the eleven observing instruments on the spacecraft; its function is to observe in UV wavelengths. As our sponsor was the principal investigator for this device, we had the opportunity to experience the encounter first-hand. In preparation for the event, programs were written to simulate the data that would be received by the instrument during the occultation of Sigma Sagittarius, data that was to reveal vital information about the size and number of Neptune's rings. Accompanying this was a program that simulated particles within a ring system, based on a predicted density law.

Interactive Environment for Simulation of Complex Robotic Systems

Alvin Law and Ming Lee Sponsors: Ken Kreutz and Abhinanda Jain

This project supports the development of a dynamical simulation environment of a system of multiple constrained robotic manipulators. Computer software was developed for the numerical calculations of the dynamical equations of motion describing a system of two robot arms rigidly grasping the same object. The developed routines were then used to test control, load balancing, and path planning algorithms in the simulation environment. Also developed were user interfaces to the simulation environment which facilitated the input, extraction, and interpretation of information specific to the behavior of closed chain systems.

Analysis of the Laboratory Spectra of Chlorofluorocarbons

Kyung Lee Sponsor: Linda Brown and Michael Gunson

The main purpose of this SURF project is the analysis of laboratory infrared spectra of chlorofluorocarbons, CFC-12, CFC-11, for the spectral region near 11 microns. The project's specific objective is to study the frequency, absorption amount, and temperature dependence of the absorption in order to model the behavior of the gases in the real earth atmosphere. Because of the huge amount of data and complexity of the task, computers were required for graphics presentation, file manipulation, and calculation. As an initial part of the work, existing FORTRAN codes were integrated to create a new set of programs tailored for this particular task. The second portion of the work was to apply these programs to existing laboratory absorption spectra recorded at high resolution by a Fourier transform spectrometer to convert the raw spectral data into specially formatted catalogs of spectral parameters of important vibration-rotation bands observed in the atmospheric remote sensing data.

Phase Functions for NTrZ, NTeZ, NEB, and SEB Derived from Voyager High- and Low-Phase Angle Observations: Are Zones Really Belts in Sheep's Clothing?

David Max Sponsor: Kevin Baines

Aerosol phase functions for the orange filters of the Voyager 1 wide-angle camera are calculated for several latitudes on Jupiter, and comparisons made with the earlier analyses of the Pioneer Imaging Photopolarimeter observations reported by Doose et al. (Proc. of the Conf. on Jovian Atmospheres, 83-93, 1986) and Tomasko et al. (ICARUS 33, 558-592, 1978). In this analysis, we follow the technique of Doose et al. to find the double Henyey-Greenstein phase function parameters of a cloud layer lying below a stratospheric haze. This atmospheric structure corresponds to the Type II structure of Tomasko et al. and the Type I structure of Doose et al.

This investigation represents a continuation of a similar project begun, but never finished, by Alan Amundsen in 1987. Preliminary analysis of the orange filter data suggests that the phase functions for belts and zones are similar. This implies that differences between zones and belts may lie mostly in their color and physical and optical depths, and not in their size and shape.

Exploding Stars, Forest Fires, and Close Encounters

Andrea Mejia, Celina Mikolajczak Sponsor: Eleanor Helin

Through participation in the Planet Crossing Asteroid Survey (PCAS), we were part of a team which discovered 41 new objects. Among them were a Mars crossing asteroid, 1989NA, and the sixth closest approaching and now best studied Apollo type asteroid, 1989PB. Our group was also the first to recover Brorsen-Metcalf, a comet with a 76-year period. In addition we had our own observing program designed to search for comets. Although we did not find any new comets, we did discover a supernova, designated SN 1989N, in the spiral galaxy NGC 3646.

Spacecraft Constraint Checking on the Hypercube Concurrent Processor

Louise Perry Sponsor: Joan Horvath

Before sequences of commands can be sent to an unmanned spacecraft, they must be checked for hardware and software constraints. This form of discrete event simulation, in its current sequential implementation, takes each command in time order and models its effect on the spacecraft. Using a parallel processor, commands can be checked independently and increase the speed of the task. This Mission Profile and Sequencing Section at JPL is developing a prototype for constraint checking on the JPL/Caltech Mark III hypercube concurrent processor. The algorithm is similar to discrete event simulations also being developed on the hypercube and its integration with these operating systems will be investigated.

PSR Actuation System Development

Alan M. Perzigian Sponsor: Michael Agronin

Precision Segmented Reflector, (PSR), is a technology development project whose goal is to develop primary reflector figure control technology. This is necessary because currently the maximum size of a reflector is determined by the cargo hold of its carrier vehicle. In order to create a larger reflector, it would have to be sent up in segments and assembled in space. Figure control of this large, segmented reflector cannot be achieved without an active actuation system.

A Single Axis Teleoperator System

Roland Rocafort Sponsor: Blake Hannaford

Large scale space activities such as the space station will require semiautonomous assistance by robots. This will take the form of robots controlled by human operators to perform useful tasks in space. The effect of frictional and gravitational forces is an important issue in teleoperation control. A single axis force reflecting hand controller with a gravitational and a frictional brake has been assembled. The system consists of a DC-motor driven controller, a DC-motor driven robot with a force sensor and two DC-motor driven gravitational and frictional brakes. This system will serve as a testbed for testing and comparing bilateral teleoperation control strategies under the effect of the gravitational and frictional forces. An interactive menu is provided for the user which allows for on-line updates of control parameters.

Infrared Mapping of the Jovian Stratosphere

Erik Russell Sponsor: Glenn Orton

From April, 1984, to the present, approximately 700 infrared images of Jupiter's upper atmosphere were taken, exhibiting a wide range of temperature variations in the Jovian stratosphere. The first necessary task in analyzing these images was to design and run programs to obtain positional data for each of the images, thereby making it possible to locate thermal features. Subsequently, the extinction coefficients and relative air masses for the images were calculated and atmospheric distortions were corrected. Eventually, it is hoped that this information will make it possible to quantify differences in the brightness of features over time, latitudinal and longitudinal changes of stratospheric bands and wave formations, and the fate of the bright polar streak and anomalous warm southern band in the 1988/1989 images. Presently, limited qualitative analyses are being made.

Engine Simulation

Behnam Sadeghi Sponsor: Jonas Zmuidzinas

My work is part of a project aimed at developing a fault-tolerant, air mass flow sensing system for the four-stroke, fuel injection, spark-ignition, internal combustion engine through the utilization of hardware as well as analytical redundancy.

A mathematical model for the engine was obtained. Based on the model, a computer simulation of the engine was created. The simulation allows on-line alteration of control variable by the user. The simulation will be used in conjunction with models of the sensing system once the design of the sensing system is complete.

Estimation of rms Phase Error in Phase Locked Loop to be Used in Deep Space Optical Communication

Zulfiquar Sayeed Sponsor: James Lesh

It has been proposed that coherent heterodyne detection be used for deepspace optical communication. This involves the use of phase locking. The power of the transmitted signal will be quite weak so that the consideration of noise becomes important. Mathematical models for the shot and frequency noise in the optical phase-locked-loop have been derived. The shot noise has been found to be negligible compared to the frequency noise. The rms phase error was measured in lab first using PSD estimation, and then sample variance in which the error signal is sampled at sub-nyquist rate so that the samples will be uncorrelated. In both methods the phase error measured was a hundred times smaller than that which was predicted by theory. However, the first method was not satisfactory since the data would sometimes be 150 times and sometimes 250 times smaller than theory. The next method proved more consistent with lab being within \pm 20% of theory if a linewidth of 6 or 7 Hz was considered for the lasers. The linewidth is actually 3000 Hz according to the manufacturer. It has been suggested that in lab we are actually seeing an unusual linewidth, since the rms phase error is mostly dependent on laser linewidth. Other than the laser linewidth there are not many other parameters on which we can attribute the inconsistency of theory and lab.

Ground-based CCD Imaging of Neptune in 1989

Catherine Swift Sponsor: Kevin Baines and Heidi Hammel

Digital images of Neptune were obtained on 24–30 June 1989 with the U.H. 2:24-m telescope (Mauna Kea Observatory) through filters centered on three methane bands (6190, 7270, and 8900 Å) and three nearby continuum regions (6340, 7490, and 8200 Å). An additional run is scheduled for 17-24 August 1989.

Neptune's atmosphere shows far more activity in this year's images than in images obtained in the previous three years. The same telescope, filters, and CCD camera were used, and the observing conditions were approximately the same.

In the 1989 images, at least four discrete cloud features were seen: a very bright feature at $-33^{\circ} \pm 5^{\circ}$, a fainter feature at $-53^{\circ} \pm 5^{\circ}$, and at least two faint features in the northern hemisphere. Preliminary analysis of the brightest feature's motion yields a rotation period of 18.26 \pm 0.5 hrs near -33° . The brightest features seen in 1987 and 1988 images were located at latitudes $-30^{\circ} \pm 3^{\circ}$ and $-38^{\circ} \pm$ 3° , with rotation periods of 17.7 and 17.0 hours, respectively (Hammel 1989, Science 244, 1165; Hammel et al. 1989, ICARUS 79, 1).

Solar Energy Deposition in the Uranian Atmosphere

John Werner Sponsor: Kevin Baines

In having no major internal heat source, Uranus stands out from the other gaseous giant planets. The majority of the atmospheric energy of Uranus is supplied by the sun. When a plot of solar energy deposition is made against the common log of pressure, many interesting features can be seen: 1. Most of the energy deposition is due to aerosols at the top of the equatorial atmosphere. 2. A steep local maximum just below 1 bar is thought to correspond to a CH_4 cloud. 3. Another peak at 2.5 bars is believed to correspond to the bottom of the atmosphere.

Determination of N2 Spectral Line Parameters from Infra-red Solar Absorption Spectra

Jack Yeb

Sponsor: Michael Gunson and Linda R. Brown

Measurements of line strength and collision broadening coefficients for N2 quadrupole transitions were taken from infra-red solar absorption spectra. Four transitions: S8, S9, S10, and S12 of the fundamental band, found between 2403-2433 cm-1, were studied. The spectra were obtained using a Fourier transform spectrometer at Jungfraujoch, Switzerland, and the ATMOS instrument located at both Space-Lab 3 and the Table Mountain Observatory, in the San Gabriel Mountains of southern California. The parameters will be used to determine uncertain temperature and pressure conditions, and subsequently, applications such as calculation of ATMOS' shuttle-borne viewing geometry.

High-Speed Phase Detection

Sabeer Bhatia Sponsors: Dr. R. Narasimha, Dr. R. Sunder

A circuit to determine the phase difference between two high speed analog signals has been developed. It will be interfaced with a dedicated microprocessor system to continuously monitor phase lag. The design was developed for a LASER INTERFEROME-TER using CCD technology, the microprocessor being programmed to determine the relative displacement of two points. It can find application in any system requiring high speed phasedifference determination.

Functional Domains of the Rev Protein of HIV

Jennifer Low Sponsors: Barbara Wold Tristram G. Parslow

Rev, a regulatory protein of the human immunodeficiency virus (HIV), acts within the nucleus to control the expression of mRNA encoding structural proteins of HIV. In attempting to characterize functional domains of the protein, our lab has been utilizing sitedirected mutagenesis to alter amino acid residues, and then assaying for function with a rev-dependent chloramphenicol acetyltransferase (CAT) reporter plasmid. For much of our work, we introduce these mutations into a fusion protein created by linking the steroid-binding domain of the rat glucocorticoid receptor to the Cterminus of rev. These fusions not only confer steroid regulation of rev activity, but also provide hormone-dependent nuclear translocation signals that can complement the loss of such signals from rev that might be caused by a given mutation. My own efforts are aimed at delineating the fine structure of an arginine-rich domain and of a potential a-helical domain of the protein.

Caseload of the Coroner's Office to the Year 2000

Carol Thompson Sponsors: Jeffrey Dubin, Mike Udell, J. Lawrence Cogan

The coroner's office handled 17,446 cases during fiscal year 1987-1988. Twenty-five percent of these were handled outside of the office while the remaining 75 percent entered the facilities. Of those which entered the facilities, only 54 percent were autopsied. It is believed that this percentage has been declining due to staffing shortages. To assist in preparing for future staffing needs, we projected the number of cases which will enter the office to the year 2000.

V71 ·1 1

While background materials, related results, and other attempts at solving the problem may be found in books and journals, insight into a problem, and its possible resolution, come about only through a student's systematic attack on the problem.

SURF Publications

- 1. "Crustal Structure Near the Eastern Transverse Ranges," EOS, 60, p. 876 (Abstract), N.W. Clayton*, J.B. Minster**.
- "Coulomb Distortion of Pion Spectra from Heavy-Ion Collisions," *Physical Review Letters*, Vol. 43, No. 1, p. 1581-1584 (1979), K.G. Libbrecht*, S.E. Koonin**.
- "Flux Pinning by Magnetic Impurities in an Amorphous Superconducting Alloy," Report to the Department of Energy, (1980), D.L. Whiting*, (worked with W. Johnson**).
- 4. "IUE and Visual Spectrophotometry of Markarian 9, Markarian 10, and 3C 390.3," Astrophysical Journal, Vol. 243, p. 445 (1981), R.W. Goodrich*, J.B. Oke**.
- "Structure and Transcription of Normal and Abnormal Globin Genes," Journal of Supermolecular Structure of Cellular Biochemistry, Supp. 5, p. 381 (1981), N. Proudfoot, M. Shander, S. VandeWoude*, T. Maniatis**.
- "Repetitive Sequences of the Sea Urchin Genome II. Subfamily Structure and Evolutionary Conservation," *Journal of Molecular Biology*, 149, p. 15-39 (1981), R.H. Scheller, D.M. Anderson, J.W. Posakony, L.B. McAllister*, R.J. Britten, E.H. Davidson**.
- "Repetitive Sequences of the Sea Urchin Genome: Distribution of Members of Specific Repetitive Families," *Journal of Molecular Biology*, 145, p. 5-28 (1981), D.M. Anderson, R.H. Scheller, J.W. Posakony, L.B. McAllister*, S.G. Trabert, C. Beall, R.J. Britten, E.H. Davidson**.
- "Molecular Basis of Genetic Defects in Human Globin Genes," Journal of Supermolecular Structure of Cellular Biochemistry, Supp. 5, 229 (1981), M. Shander, S. VandeWoude*, N. Proudfoot, T. Maniatis**.
- "Organization and Expression of Multiple Actin Genes in the Sea Urchin," Molecular and Cellular Biology, Vol. 1, No. 7, p. 609-628 (July 1981), R.H. Scheller, L.B. McAllister*, W.R. Crain, Jr., D.S. Durica, J.W. Posakony, T.L. Thomas, R.J. Britten, E.H. Davidson**.
- "Infrared Photometric Observation of BL Lac Object BL Lacertae (2200-42)," Annual Report of the Mount Wilson and Las Companas Observatories, 1981-1982, R. Pogge* (worked with G. Neugebauer**).
- "Absolute Spectrophotometry of Very Large Redshift Quasars," Astrophysical Journal, Vol. 255, p.11 (1982), D. Korycansky*, J.B. Oke**.
- 12. "Experimental Study of Autorotation with Flow Visualization," Received Third Place Certificate of Merit at American Institute of Aeronautics and Astronautics Minta Martin Student Competition for presentation of a technical paper, University of California, Irvine, April, 1982, I. Sugioka* (worked with F.E.C. Culick**).
- "Electrical Characteristics of Thin Film Ni₂Si, NiSi and NiSi₂ Layers Grown on Silicon," Paper presented at the Electronic Materials Conference 1982, June 23-25, Colorado State University, Ft. Collins, CO, *Journal of Electronic Materials*, Vol. 12, p. 413 (1983), E. Colgan* (worked with M-A. Nicolet**).
- "Erosion of Frozen Sulfur Dioxide by Ion Bombardment: Applications to IO," Geophysical Research Letters, Vol. 9, No. 10 (October 1982), pp. 1151-54, C.L. Melcher, D.J. LePoire*, B.H. Cooper, T.A. Tombrello**.
- "Shock Compaction of Ferrous Alloy Powders," Proceedings of the Third Conference on Rapid Solidification Processing at the National Bureau of Standards, Gaithersburg, MD, December 6-8, 1982, ed. R. Mehrabian, p. 672, T.J. Ahrens, D. Kostka*, P. Kasiraj, T. Vreeland**.

- 16. "Interspersed Sequence Organization and Developmental Representation of Cloned Poly (A) RNAs from Sea Urchin Eggs," *Journal of Molecular Biology*, 167, p. 361-389 (1983), J.W. Posakony, C.N. Flytzanis, R.J. Britten, E.J. Davidson**. (Gary Mockli* helped with this work though not an author on the paper).
- 17. "Sputtering of SO₂ by High Energy Ions," *Radiation Effects*, Vol. 71, pp. 245-259 (1983), D.J. LePoire*, B.H. Cooper, C.L. Melcher, T.A. Tombrello**.
- "Two-Phase Gravitational Instabilities in Thin Disks with Application to the Origin of the Moon," *Lunar & Planetary Science Abstracts*, Vol. XIV p. 787-788 (1983), *Astrophysical Journal*, Vol. 333 (Oct. 1, 1988) A.C. Thompson*, D.J. Stevenson**.
- "Study of Ni-Nb System by Ion Mixing," *physica status solidi (a)*, 77, p. 355-359 (1983), K.T. Kung*, B.X. Liu, M-A. Nicolet**.
- "Electrical Characteristics of Amorphous Iron-Tungsten Contacts on Silicon," *Applied Physics Letters*, 42 (11), p. 987-989 (1 June 1983), M. Finetti, E. T-S. Pan*, I. Suni, M-A Nicolet**.
- 21. "Kinetic Grain Flow in a Vertical Chamber," International Journal of Multiphase Flow, Vol. 12, pp. 289-298 (1986), K. Hui*, P. Haff**.
- "A Possible Phase Transition in (Zt2Ni)1-8Bx Metallic Glasses," *Physics Letters*, Vol. 98A, No. 7, p. 353-356 (31 October 1983), A.Y.L. Mak*, K. Sawmer, W.L. Johnson**.
- 23. "Shock Wave Consolidation of an Amorphous Alloy," Journal of Non-Crystal Solids, 61 & 62, p. 967-971 (1984), P. Kasiraj, D. Kostka*, T. Vreeland, Jr.**, and T.J. Ahrens.
- 24. "X-Ray, Radio, and Infrared Observations of the 'Rapid Burster' (MXB 1730-335) During 1979 and 1980," *The Astrophysical Journal*, 267, p. 301-309 (April 1, 1983), R. Pogge*, et al. (worked with G. Neugebauer**).
- 25. "Formation of the Galilean Satellites in a Gaseous Nebula," ICARUS, 52, p. 14-39 (1982), J.I. Lunine* and D.J. Stevenson**.
- 26. "The Relative Timing of Microwaves and Hard X-Rays in Solar Flares," *The Astrophysical Journal*, 279, p. 875-81 (April 15, 1984), M.E. Cornell* (worked with H. Zirin**), G.J. Hurford, A.L. Kiplinger, B.R. Dennis.
- "Assessing Constituency Involvement: The Hemel Hempstead Experience," *Parliamentary Affairs*, Vol. 35, No. 1, p. 73-83 (Winter, 1982), D.B. Ritchie*, B.E. Cain**.
- 28. "Atomic Level Populations in the Hollow Cathode Discharge," Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 31, No. 1, pp. 1-5 (1984), J.N. Humphrey*, D.L. Adams, W. Whaling**.
- 29. "Hemispheric Differences in Split-Brain Monkeys Viewing and Responding to Videotape Recordings," *Behavioral and Neural Biology*, 41, p. 231-235 (1984), C.K. Ifune*, B.A. Vermeire, C.R. Hamilton**.
- 30. "Beta-Decay Phenomenology of Nuclear Fission Products," Nuclear Physics, A411, p. 199-208 (1983), J.A. Behr* and P. Vogel**.
- 31. "Study of Charge Asymmetry in the Reaction e⁺ + e⁻u⁺ + u⁻ with the Forward Counters of the Mark J. Detector at Petra," *The Journal of Undergraduate Research in Physics*, Vol. III, No. 1, T.L. Kwok* (worked with H. Newman**).
- 32. "Experimental and Theoretical Studies of Monoclonal Anti-BSA-BSA Immune Complexes," D.M. Yarmush, J. Dunn*, C.K. Colton**, M.L. Yarmush.
- 33. "Determination of the Proximity Potential from Sub-Barrier Fusion Data," Physical Review, C30, 175 (1984), M. Inui* and S.E. Koonin**.

- 34. "Magnetosonic Waves and Streaming Energetic Ions in the Distant Plasma Sheet Boundary Layer," EOS, B.T. Tsurutani**, I.B. Richardson, R.M. Thorne, W. Butler*, E.J. Smith, S.W. Cowley, S.P. Gary, S.I. Akasofu, R.D. Zwicki.
- 35. "Observation of the Right-Hand Resonant Ion Beam Instability in the Distant Plasma Sheet Boundary Layer," *Journal of Geophysical Research*, Vol. 90, p. 1259 (1985), B.T. Tsurutani**, I.B. Richardson, R.M. Thorne, W. Butler*, E.J. Smith, S.W.T. Cowley, S.P. Gary, S.I. Akasofu, R.D. Zwicki.
- 36. "Correction to the Observations of the Right-Hand Resonant Ion Beam Instability in the Distant Plasma Sheet Boundary Layer," *Journal of Geophysical Research*, Vol. 12, p. 4606, (1986), B.T. Tsurutani**, I.B. Richardson, R.M. Thorne, W. Butler*, E.J. Smith, S.W.T. Cowley, S.P. Gary, S.I. Akasofu, R.D. Zwicki.
- "Computations and Estimates of Rate Coefficients for Hydrocarbon Reactions of Interest to the Atmospheres of the Outer Solar System," *ICARUS*, 56, p. 560-567 (1983), A.H. Laufer, E.P Gardner, T.L. Kwok*, Y.L. Yung**.
- "Studies of Extreme-Ultraviolet Emission from Rydberg Series of H₂ by Electron Impact," *Physical Review A*, Vol. 29, No. 2 (February 1984), J.M. Ajello, D. Shemansky, T.L. Kwok*, Y.L. Yung**.
- "Isolation of New Yeast DNA Replication Mutants Using Permeabilized Cells," Proceedings of the National Academy of Science USA, 80, p. 6465-6469 (1983), C. Kuo, N-H. Huang*, J. Campbell**.
- "Suppressors of a Temperature-Sensitive Copy-Number Mutation in Plasmid NTP1," *Molecular and General Genetics*, 192, p. 95-100 (1983), D.R. Moser, C.D. Moser, E. Sinn*, J.L. Campbell**.
- 41. "Association of Gap Junctions with Endoplasmic Reticulum in Rat Parotid Glands," *Cell Tissue Research*, 238, p. 589-594 (1984), J. Dunn* and J-P. Revel**.
- "Proliferation of Thymic Stem Cells With and Without Receptors for Interleukin 2: Implications for Intrathymic Antigen Recognition," *Journal of Experimental Medicine*, Vol. 161, p. 1048-1062 (May, 1985), J.P. Lugo, S.N. Krishnan*, R.D. Sailor, P. Koen, T. Malek, E. Rothenberg**.
- "Experimental Studies of Phase Conjugation with Depleted Pumps in Photorefractive Media," Optics Letters, Vol. 10, No. 7, p. 359-361 (July 1985), S-K. Kwong, Y-H Chung*, M. Cronin-Golomb, A. Yariv**.
- 44. "Instrument to Collect Fogwater for Chemical Analysis," Review of Scientific Instruments, 56, 6 (June 1985), D.J. Jacob, J.M. Waldman, M. Haghi*, M.R. Hoffmann, R.C. Flagan**.
- "California's First Barbecue?: A Paleomagnetic Study of the Hearth Feature at the Calico Archeological Site," *Anthroquest*, No. 34 (Spring, 1986), J.L. Boley* (worked with J. Kirschvink**).
- "Comparison of Theory with Experiment in Convectionless Growth of Crystals from Solution," *Journal of Crystal Growth*, 71, p. 791-794 (1985), D.G. Schlom*, P.J. Shlichta**.
- "Pair-Induced Spectral Changes and Variability in Compact X-Ray Sources," Monthly Notices of the Royal Astronomical Society, Vol. 221, p. 931 (1986), A.C. Fabian, R.D. Blandford**, P.W. Guilbert, E.S. Phinney, L. Cuellar*.
- "Motions in the Interiors and Atmospheres of Jupiter and Saturn," ICARUS 65, p. 370-382 (1986), A.P. Ingersoll*, R.L. Miller**.

- 49. "A Reassessment of a Hearth-like Feature at the Calico Site Using Thermoluminescence, Electron Spin Resonance, Paleomagnetic, and 40-39 Argon Techniques," *Current Research in the Pleistocene*, Vol. 3, 1986, edited by Jim I. Mead, Center for the Study of Early Man, University of Maine, Orono, F.E. Budinger, Jr., J.L. Boley*, (worked with J.L. Kirschvink**), A.R. Gillespie.
- 50. "Evidence for Non-Axisymmetric Nuclear Bulges in Spiral Galaxies," Astrophysical Journal, 303, p. 66 (1986), D. Zaritsky*, K.Y. Lo**.
- "A New Proof of Erdos's Theorem on Monotone Multiplicative Functions," American Mathematical Monthly, Vol. 93, Num. 8, October 1986, E. Howe*, T. Apostol**.
- 52. "New Superconducting-quantum-interference-device-based Constraints on the Abundance of Magnetic Monopoles Trapped in Matter: An Investigation of Deeply Buried Rocks," *Physical Review A*, Vol. 33, No. 2 (February 1986), J.M. Kovalik*, J.L. Kirschvink**.
- 53. "On the Capacity of Certain Associative Memories," *IEEE Transcript on Information Theory*, Vol. IT-31, p. 461-464 (July 1985), Y. Abu-Mostafa** and J. St. Jacques. Also a paper delivered at IEEE International Symposium on Information Study, Brighton, England, June 23-28, 1985.
- "Hexanuclear Tungsten Cluster Structures: W6Cl14, W6Br14, W6I14. Relevance to Unusual Emissive Behavior," *Inorganic Chemistry*, 25. p. 2195 (1986), T. Zietlow, W.P. Schaefer**, B. Sadeghi*, N. Hua, H.B. Gray**.
- 55. "Preparation and Properties [(C6H3)3P)2N]W6Bt14," Inorganic Chemistry, 25, p. 2198 (1986), T.C. Zietlow, W.P. Schaefer**, B. Sadeghi*, D.G. Nocera, H.B. Gray.
- 56. "Fe II Level Populations in a Hollow Cathode Discharge," Journal of Quantitative Spectroscopy and Radiative Transfer, Vol. 38, No. 1, p. 1-4 (1987), R.S. Hudson*, L.L. Skrumeda, W. Whaling**.
- 57. "Fiber Optic Link Characterization Via Local Network Performance Measures," submitted to *Optical Society of America*, (1987), L.A. Bergman**, R. Hartmayer, F. Halloran, S. Marelid*.
- "Lithium in the Pleiades and Alpha Persei Clusters," submitted to *The Astrophysical Journal*, Vol. 327, p. 389 (1988), A.M. Boesgaard**, K.G. Budge, M.E. Ramsay*.
- 59. "The Distance to M5 From Its RR Lyrae Variables," The Astrophysical Journal, 318, p. 215 (1987), J.G. Cohen**, G.A. Gordon*.
- 60. "Type II Ca²⁺/Calmodulin-Dependent Protein Kinase in Drosophila," Society for Neuroscience, Vol. 13 (1987), D.S. Leonard, J.B. Wall, P.C. Pugh*, and M.B. Kennedy**.
- 61. "Polarized CCD Imaging of the Horsehead Nebula (B33) and Monoceros R2," Astronomical Journal, Vol. 93, No. 6, p. 1514 (1987), D. Zaritsky*, E.J. Shaya, N.Z. Scoville**, A.J. Sargent, D. Tytler.
- 62. "Gas-Driven Water Volcanism and the Resurfacing of Europa," ICARUS 73, p. 66-79 (1988), Glen D. Crawford*, David J. Stevenson**.
- 63. "A Directed Graph Version of Strongly Regular Graphs," Journal of Combinational Theory, Series A., Vol. 47, No. 1, p. 71-100 (January 1988), A.M. Duval* (worked with H.J. Ryser and R.M. Wilson).

- 64. "Price and Population History in Rural Fengtian 1772-1873," prepared for the American Council of Learned Societies/Social Science Research Council Conference on "Economic Methods for Chinese Historical Research," Oracle, Arizona, January, 1988, *Quingdai Quyu Shehui Jingji Shi* (Regional Social and Economic History of the Ching), edited by Ye Xianen, Centre Nationale De Recherches Scientifique, 1987; submitted for English to the University of California Press as part of a conference volume *Chinese History in Economic Perspective*, edited by Lillian Li and Thomas Rawski, James Lee**, Cameron Campbell*, Guofu Tan.
- 65. "A Century of Mortality in Rural Liaoning, 1774-1873," Le Peuplement Du Monde Avant 1850, edited by Antoinette Fauve-Chamoux, Centre Nationale De Recherches Scientifique, Paris, 1988, James Lee**, Cameron Campbell*, Lawrence Anthony.
- "Net NMR Alignment by Adiabatic Transport of Parahydrogen Addition Products to High Magnetic Field," *Chemical Physics Letters*, Vol. 45, No. 4 (April 8, 1988), M.G. Pravica*, D.P. Weitekamp**.
- 67. "Universality of Random Matrix Predictions for the Statistics of Energy Levels," *Physics Review Letters*, Vol. 60, Num. 20, pp. 1995-1998, May 16, 1988, Randall D. Kamien*, H.D. Politzer**, M.B. Wise**.
- 68. "Calibration of the L3 BGO Electromagnetic Calorimeter With a Radiofrequency Quadrupole Excelerator," accepted for publication in *Nuclear Instruments and Methods*, H. Ma, R. Mount, H. Newman**, F. Roeber*, R. Zhu, H. Akbari, R. Hamm.
- "Spectrophotometry of the Uranian Satellite," Poster talk from Uranus Conference, June 28-July 1, 1988, Pasadena, CA, Abstract #5.11, B. Buratti**, R. Nelson, J. Mosher, F. Wong*.
- "Computing Optical Flow in the Primate Visual System," The Computing Neuron, R. Durbin, C. Miall, G. Mitchinson, eds., Addison Wesley (In press), H. T. Wang, B. Mathur, A. Hsu*, C. Koch**.
- 71. "Small-scale Structure in the Jovian Stratospheric Temperature Field," presentation to the American Astronomical Society/Division for Planetary Science on November 1988 in Austin, Texas, G.S. Orton**, A.J. Friedson, J. Caldwell, M.E. Malcom*, I.A. Avruch*
- 72. "A Novel Bioreactor-Cell Precipitator Combination for High Cell Density, High Flow Continuous Fermentations," *Biotechnology Progress*, Vol. 1, No. 4, pp. 250-259, December, 1985, Gregory Stephanopoulos**, K.-Y. San, B.H. Davison, (Mark Phoniadakis*)
- 73. "Mars: Near-Infrared Comparative Spectroscopy during the 1986 Opposition," ICARUS, 77, pp. 21-34, 1989, James F. Bell III*, Thomas B. McCord**.
- 74. "Simple, High Current LaB₆ Cathode," 1989 American Institute of Physics, p. 964-965, Karen Siegrist*, M.R. Brown, and Paul M. Bellan**.
- 75. "Ground-based CCD Imaging of Neptune in 1989," Bulletin of the American Astronomical Society, 1989, Catherine E. Swift*, Heidi B. Hammel.
- 76. "The Shape of Eros," submitted to ICARUS, June 1989, S.J. Ostro**, Keith D. Rosema*, R.F. Jurgens.
- 77. "A Paleomagnetic Constraint on the Late Cretaceous Paleoposition of Northwestern Baja California, Mexico," *Journal of Geophysical Research*, Vol. 94, No. B6, pp. 7332-7342, June 10, 1989, P.E. Filmer*, J.L. Kirschvink**.

* = SURF student

** = SURF sponsor

Amin Abid Senior, EE

Syed Zubair Ahmad Senior, EE/Ph

Keith Akama Junior, Bi Richter SURF

John Apostolopoulos Senior, EE Massachusetts Institute of Technology

Jesus Arcilla Sophomore, EAS/Ec

Sophia Asghar Senior, Ph/EE Muskingum College

Fred Ayres Senior, Ch Reed College

Mohammad Azeem Junior, EE

Joseph Bach Junior, EAS Ford SURF

Boyd Bangerter Junior, Ph/EE GM SURF

Stephen Bard Senior, Ma

Topic

Concept, Analysis, and Design of a BCD for Mariner Mark II Spacecraft

MicroMITE Satellite Antenna System Design and Analysis

Generation of Monoclonal Antibodies Against Rat Embryonic Visual Cortex

Acquisition and Tracking for a Deep-Space Laser Conjunication System

OGCM Data Gathering and Manipulation

The Effects of Temporal Delay on Multigigabit/sec Coherent Fiber Optic Network Systems

Synthesis Characterization and Electrochemistry of Cobalt Cyclan Complex

MicroMITES Power Supply System Design and Analysis

Shock Wave Consolidation of Metallic Glasses

Stabilization of Arcs in Electric Furnaces

Minimal Graphs with Large Girth and Large Chromatic Number

Sponsor

John W. Klein Group Supervisor, Power Systems Engineer, JPL

Robert C. Clauss Systems Development Program Manager, TDA Office, JPL Edward C. Posner Visiting Professor of Electrical Engineering

John M. Allman Hixon Professor of Psychobiology and Professor of Biology

James P. Lesh Supervisor, Optical Communications, JPL

David Halpern Senior Research Scientist, JPL

Larry A. Bergman Technical Group Leader, Optic Fiber Networking, JPL

Fred C. Anson Professor of Chemistry

Robert C. Clauss Systems Development Program Manager, TDA Office, JPL Edward C. Posner Visiting Professor of Electrical Engineering

Brent T. Fultz Assistant Professor of Materials Science

Paul M. Bellan Associate Professor of Applied Physics Michael R. Brown Research Fellow in Applied Physics

Joseph A. Gallian Professor of Mathematics, University of Minnesota, Duluth

Jeannie Barrett Sophomore, Bi/Ch Bristol-Myers SURF

Sabeer Bhatia Junior, EE Colvin International SURF

Sandip Biswal Senior, Biology Thomas Hunt Morgan SURF

Seth Bittker Junior, Ma Richter SURF

Charles Blake Junior, Ph NSF SURF

Brett Bochner Junior, Ph

John-David Bondy Junior, Bi/Ch Texas A & M NSF SURF

Janet Bowen Junior, Ma Harvard University

Brian Brandt Senior, Bi NSF SURF

Mary Bullington Senior, Management and Technology University of Pennsylvania

Herb Burrows Senior, EE

Topic

Exploring Gap Junctions With Microscopy

High-Speed Phase Detection

Cytoskeletal and Adhesion Proteins of the Mesozoan

Thermal Model of the Interior of Mars

Project SEED

Nonequilibrium Chemistry Modeling of the Methane and Ammonia Abundances of Halley's Comet and Other Important Comets

A Model System for the Study of Magnetic Spillover in NMR and Diffusion Studies

Tunable Far Infrared Laser Spectroscopy of the Water-Nitrogen Complex

Temporal Coherence and Oscillations in the Visual Cortex

Plan for Task Scheduling and Resource Allocation

Measurement of the Light Scattering Properties of Icy Planetary Surfaces

Sponsor

Jean-Paul Revel Albert Billings Ruddock Professor of Biology

R. Narasimha Director, National Aeronautical Laboratory, Bangalore, India R. Sunder Head, Fatigue and Fracture Laboratory, Structures Division, National Aeronautical Laboratory, Bangalore, India

Jean-Paul Revel Albert Billings Ruddock Professor of Biology

David J. Stevenson V Professor of Planetary Science

James M. Bower Assistant Professor of Biology

Mark A. Allen Member of the Technical Staff, JPL

John D. Roberts // Institute Professor of Chemistry, Emeritus

Bruce C. Murray Professor of Planetary Science Geoffrey Blake Assistant Professor of Cosmochemistry

Daniel M. Kammen Chaim Weizmann Postdoctoral Fellow in Computation and Neural Systems

William M. Whitney Division Technologist, JPL Martin Liepold Member, Technical Staff, JPL

Bonnie J. Buratti Member of the Technical Staff, JPL

Chris Campo Junior, Ay

Lawrence Canino, Jr. Junior, Ph Unitek SURF

Huy Cao Senior, Ma NSF SURF

Robert Chang Sophomore, Ph

Kevin Chase Junior, AMa/Ph

Andrew Chen Senior, Ph/AMa Ford SURF

John Chen Senior, EE/Ma

Leonard Chen Junior, EE GM SURF

Helen Hsin-I Cheng Junior, Bi

Gavin Chilcott Junior, Bi Santa Rosa Junior College

Tien-Yee Chiu Junior, Ma

Mike Chou Junior, Ph

Gladys Chow Sophomore, EAS/CS

Topic

Solid CO Abundance in Young Stellar Objects

Optically Detected Magnetic Resonance of Gallium Arsenide

Generating Error-Correcting Codes

Laser Counter for the Mark IV Stellar Interferometer

Sensor Modelling for Automotive Applications

Spectroscopy of Molecular Ions and Clusters

MicroMite Satellite

A Robust Analysis of Acoustic Instabilities in Combustion Chambers

Mapping of the Facial Nucleus in the Motor Cortex of the Rat Brain

Internal Perfusion of *Xenopus laevis* Oocytes Using Glass Pipettes

A Look at Colloquial Professional Naming Conventions and Gender Assumptions

A Search for ²H, ³H and ³He in Large Solar Flares

Manufacturing Cost Model Development

Sponsor

Mark A. Allen Member of the Technical Staff, JPL

Daniel P. Weitekamp V Assistant Professor of Chemistry

Heeralal Janwa Bateman Research Instructor in Mathematics

James B. Breckinridge Technical Section Manager, Optical Services and Applications, JPL

Jonas S. Zmuidzinas Member of the Technical Staff, Space Physics and Astrophysics, JPL

Mitchio Okumura Assistant Professor of Chemical Physics

Robert C. Clauss Systems Development Program Manager, TDA Office, JPL Edward C. Posner Visiting Professor of Electrical Engineering

Athanasios Sideris Assistant Professor of Electrical Engineering

John M. Allman Hixon Professor of Psychobiology and Professor of Biology

Henry A. Lester Professor of Biology

Bozena H. Thompson Senior Research Associate in Linguistics and Lecturer in Linguistics

Richard A. Mewaldt Senior Research Associate in Physics

Gaylord E. Nichols Industrial Relations Center

Vivian Chow Senior, EAS/CS NSF SURF

Samuel Clark Sophomore, Bi/ME

Philip Collins Senior, Ph/EE Massachusetts Institute of Technology

David Cutter Sophomore, APh Ford NSF

Aditya Datta Senior, Ph/Ma

Nathan Diachun Senior, Ch State University of New York (SUNY) at Buffalo NSF SURF

Mark Dinan Junior, Ph NSF SURF

David Edwards Junior, AMa

Stephen Edwards Sophomore, EE AMETEK SURF

Michael D. Ehlers Junior, Ch Krown SURF

David Emerson Junior, EE Alumni SURF

Oguz Ersoy Senior, Bi Bates College

Topic

Telephone/Computer

SURFing in Windhoek

The Characterization of a Free-Expansion Dust Gun

Spheromak Equilibrium in a Tokamak Vessel

Study of Liquid Phase Epitaxy in Bismet-Based High Temperature Superconductors

Gas Phase Reactions of Co⁺

Project SEED

Industrial Relations in Southern California, 1944–80: A Study of Employee Opinion Polls

A High-Level Language Processor Based on the ASP Chip

Site-Directed Mutagenesis of Beta-Lactamase and the Role of General Recombination in the Excision of Gene Inserts in the M13 Bacteriophage

Distributed Vision Processing Algorithms

Isolation of Homologous Genes to Fasciclin I in Drosophila Melanogaster

Sponsor

Charles L. Seitz Professor of Computer Science

Edwin S. Munger Professor of Geography, Emeritus

Gregory H. Bearman Member of the Technical Staff, JPL James G. Bradley Supervisor, Analytical Instrument Group, JPL

Paul M. Bellan Associate Professor of Applied Physics Michael R. Brown Research Fellow in Applied Physics

Robert M. Housley Visiting Associate in Physics

Jesse L. Beauchamp Professor of Chemistry

James M. Bower Assistant Professor of Biology

Doug Flamming Assistant Professor of History

Rodney M.F. Goodman Associate Professor of Electrical Engineering

John H. Richards Professor of Organic Chemistry

Rodney M.F. Goodman Associate Professor of Electrical Engineering

Kai Zinn Assistant Professor of Biology

Glenn Eychaner Senior, Ge Class of '36 SURF

Wen-Hsiu Fan Senior, Bi Beijing University NSF SURF

George Fang Senior, EE

Robert Fox Senior, APh Pacific Telesis SURF

Tracy Fu Sophomore, APh

Eric Fung Junior, Bi

Amar Gandhi Junior, EAS

Milind Gangal Senior, Bi

David Geraghty Junior, EE

Delwyn Gilmore Sophomore, EAS Ford SURF

Christiana Goh Sophomore, EE/Management Science Massachusetts Institute of Technology

Topic

Transverse Solar Magnetic Fields

Mapping the MoxE Gene of Methylobacterium AM1

MicroMite Satellite

Moire Pattern Ion Channeling Lithography

Computer Control of a MBE Machine

Muscle Fiber Elimination During Synapse Elimination

Structure of Triton

Selection of Mutants Using the Gene-Fusion Approach

Growth of InGaAs Quantum Well Lasers in V-Grooves

Fabrication and Characterization of n-Silicon Metal/Insulator/Semiconductor Devices

The VME Bus-Photon Camera Interface

Sponsor

Harold Zirin Professor of Astrophysics

Mary E. Lidstrom Associate Professor of Applied Microbiology

Robert C. Clauss Systems Development Program Manager, TDA Office, JPL Edward C. Posner Visiting Professor of Electrical Engineering

Harry A. Atwater, Jr. Assistant Professor of Applied Physics

Thomas C. McGill Fletcher Jones Professor of Applied Physics

David C. Van Essen Professor of Biology

David J. Stevenson Professor of Planetary Science

Scott D. Emr Associate Professor of Biology

Amnon Yariv Thomas G. Myers Professor of Electrical Engineering and Professor of Applied Physics Lars E. Eng Graduate Student

Nathan S. Lewis Associate Professor of Chemistry

Mike Shao Group Supervisor, Spatial Interferometry, JPL

Varoujan Gorjian Junior, Ay Flintridge SURF

Roman Gutierrez Junior, APh

Kimulique Harkley Senior, Bi Clark College

Eric Hassenzahl Senior, EAS/ME The Associates of Northern California SURF

Laura Hernandez Senior, Bi/Eng NSF SURF

Jay Higley Junior, APh

Li Wen Ho Senior, Ma Richter SURF

Jackie Holmes Junior, CE Krown SURF

Gary Holt Junior, Bi NSF SURF

Douglas Huang Senior, EE

Hoyt Hudson Sophomore, APh/Lit

Mark Huie Senior, EE

Topic

Constructing VLA Maps of Microwave Sources

Programming for Robot Control System and Analysis

Identification of Molecules that Define Rostrocaudal Positions in the Mammalian Nervous System

Cavitation Nucleus Injector

Characterization of Virus Transport Through Porous Media

Stabilization of Arcs in Electric Furnaces

Topological Spaces

Industrial Relations in Southern California, 1944–80: A Study of Employee Opinion Polls

A Model for Direction Selectivity and Velocity Tuning in Visual Cortical Cells

Design, Fabrication, and Testing of the Telecommunication System of μ MITES

Feasibility Study of Glass Sequestering of Toxic Metals

Infrared Telescope Image Processing, Calibration and Interpretation

Sponsor

Anthony C.S. Readhead Professor of Radio Astronomy

Guillermo Rodriguez Group Supervisor, Tele/Autonomous Systems Group, JPL

Paul H. Patterson Professor of Biology Zaven Kaprielian Research Fellow in Behavioral Biology

Allan J. Acosta Professor of Mechanical Engineering

Mary E. Lidstrom Associate Professor of Applied Microbiology

Paul M. Bellan Associate Professor of Applied Physics Michael R. Brown Research Fellow in Applied Physics

Wilhelmus A.J. Luxemburg Professor of Mathematics

Doug Flamming Assistant Professor of History

Christof Koch Assistant Professor of Computation and Neural Systems

Robert C. Clauss Systems Development Program Manager, TDA Office, JPL Edward C. Posner Visiting Professor of Electrical Engineering

James Stephens Member, Technical Staff, JPL

Glen Orton Member, Technical Staff, JPL

Stephen Hwan Junior, EE L.A. Times SURF

Yayoi Izumi Junior, EAS

Saeed Nawaz Jaffer Sophomore, EE/Ec Massachusetts Institute of Technology

Sandeep Jain Senior, Ph Pomona College

Sean Johnston Senior, Bi/Ch Bristol-Myers SURF

Lauren Jones Junior, Ay Vassar College

Michael Jones Senior, CE William N. Lacy SURF

Ari Kaplan Sophomore, EAS Krown SURF

Anthony Kewitsch Senior, EE/Ph Stanford University

Zulfiqar Khan Junior, EE/Ma NSF SURF

David Kim Junior, Ph NSF SURF

Dong-Su Kim Junior, APh GM SURF

Jinha Kim Junior, Ph

Topic

Voting Patterns in the California State Assembly

Project SEED

Numerical Model Simulation of Large Scale Ocean Circulation

Fault Tolerant Sensors

Determination of Tissue Specific G Proteins in Differentiated Hematopoietic Cells

Lightcurves and Pole Solutions for 1036 Ganymed

Measurement of Visibility Reduction and Airborne Particle Concentrations at Grand Canyon National Park

How Do You Spell Relief? An Analysis of Baseball Pitching, 1876 to Present

The Effect of Environmental Stress on the Performance of Q-Switched, Diode Laser Pumped Nd: YLF Ring Laser

Scope of Telephone-Computer and Such Advanced Communication Systems in the Development of Pakistan and India

Models and Improved Methods of Sample Desorption for Mass Spectrometry

The Relationship Between Cavitation and Nucleus Concentration

Quantum Mechanical Calculation of Momentum Distribution Inside the Nucleus

Sponsor

Bruce E. Cain Professor of Political Science

James M. Bower Assistant Professor of Biology

David Halpern Senior Research Scientist, JPL

Jonas S. Zmuidzinas Member of the Technical Staff, Space Physics and Astrophysics, JPL

Melvin I. Simon Anne P. and Benjamin F. Biaggini Professor of Biological Sciences

Alan W. Harris Supervisor, Earth and Planetary Physics, JPL

Glen R. Cass Associate Professor of Environmental Engineering and Mechanical Engineering

D. Roderick Kiewiet Associate Professor of Political Science

James R. Lesh Supervisor, Optical Communications, JPL

Frederick B. Thompson Professor of Applied Philosophy and Computer Science

Jesse L. Beauchamp Professor of Chemistry

Christopher E. Brennen U Professor of Mechanical Engineering

Bradley W. Filippone Assistant Professor of Physics

Keana Kim Junior, APh Pacific Telesis SURF

Tara Kirby Junior, Ch

Clifton Kiser Senior, EAS/MS

Scott Kister Junior, EE/Ec

Yu-Hung Kuo Junior, Bi/Ch

Tanya Kurosky Junior, Ph Bristol-Myers SURF

Janet Lai Junior, ChE

Mark Lakata Sophomore, Ph

Alvin Law Senior, EAS

Justin Lawyer Junior, Ph

Ngocdiep Le Junior, Bi/Ch Richter SURF

Anita Lee Junior, APh

Howard Lee Senior, APh

Kyung Lee Junior, EAS/EE

Topic

High Energy Irradiation of VO₂

Near-Infrared Analysis of Stratospheric Aerosols on Jupiter

Feasibility Study of Glass Sequestering of Toxic Metals

How to Price a Car

Pattern of Innervation by Fiber Type in the Neonatal Rabbit Soleus Muscle

Sensitive Detection of Ion Magnetic Resonance

Tunable Far-Infrared Laser Spectroscopy of the HCI Dimer

Applications of UV Astronomy

Interactive Environment for Simulation of Complex Robotic Systems

Robert Duncan and Charles Olson: The Self and the Poem

Purification of Clam Tubulin

Determination of the Temperature Coefficient of Conductivity for Random Graphite Grains in Amorphous Carbon

Molecular Dynamics Simulation of Low Energy Ion Bombardment

Analysis of the Laboratory Spectra of Chlorofluorocarbons

Sponsor

Thomas A. Tombrello, Jr. Professor of Physics

Kevin H. Baines Member of the Technical Staff, JPL

D. Dave Lawson Member of the Technical Staff, JPL

Charles R. Plott Edward S. Harkness Professor of Economics and Political Science

David C. Van Essen Professor of Biology

Daniel P. Weitekamp Assistant Professor of Chemistry

Geoffrey A. Blake Assistant Professor of Cosmochemistry

Arthur L. Lane Section Manager, Geology and Planetology, JPL

Kenneth K. Kreutz Abhinanda Jain Members of the Technical Staff, JPL

R. Scott Hamilton Mellon Postdoctoral Instructor in Literature

Jean-Paul Revel Albert Billings Ruddock Professor of Biology

Thomas A. Tombrello, Jr. Professor of Physics

Harry A. Atwater Assistant Professor of Applied Physics

Linda R. Brown Michael R. Gunson Members of the Technical Staff, JPL

Ming Lee Senior, EAS

Thomas Lenosky Senior, Ph Ernest N. Swift SURF

Lieven Leroy Sophomore, EAS

Alvin Leung Senior, EAS University of California at Santa Cruz NSF SURF

Agnes Lew Senior, Ch Occidental College NSF SURF

Ralph Lin Junior, Bi Krown SURF

Eugene Lit Junior, Bi NSF SURF

George Liu Senior, Bi

Kate Loomis Senior, EAS Richter SURF

Jennifer Low Sophomore, Bi NSF SURF

Steven Ludtke Senior, Ph

Yvonne Lung Sophomore, Bi/Ch

Topic

Interactive Environment for Simulation of Complex Robotic Systems

NMR Imaging of Solids

Pilot Land Data System Database Project

Concurrent LU Factorization

Elucidation of Electron Transfer in Blue Copper Proteins by Site-Directed Mutagenesis

The Search For a Protein Involved in the Inactivation of Rat Brain Sodium Channels

Conformation Analysis of Succinic Acid

Isolation of vps15 Suppressors

Photoelasticity and the Study of the Human Cornea

Functional Domains of the Rev Protein of (HIV)

Quantitative Comparison of Two Neutrino Detector Geometries Using Monte Carlo Techniques

Oxidation Kinetics of Bi2SrCaCu1.35Ox

Sponsor

Kenneth K. Kreutz Abhinanda Jain Members of the Technical Staff, JPL

Daniel P. Weitekamp Assistant Professor of Chemistry

Arthur L. Lane Section Manager, Geology and Planetology, JPL George Karkas Software Engineer, JPL

Manfred Morari Professor of Chemical Engineering

Hatry B. Gray Arnold O. Beckman Professor of Chemistry; Director, Beckman Institute John H. Richards Professor of Organic Chemistry

Henry A. Lester Professor of Biology

John D. Roberts Institute Professor of Chemistry, Emeritus

Scott D. Emr Assistant Professor of Biology

Wolfgang G. Knauss Professor of Aeronautics and Applied Mechanics

Barbara J. Wold Assistant Professor of Biology Tristram Parslow, M.D. University of California at San Francisco

Felix H. Boehm William L. Valentine Professor of Physics

Robert M. Housley Visiting Associate in Physics

Bruce Macartney-Filgate Junior, Ph

Raif Majeed Junior, APh Richter SURF

David Max Sophomore, EAS

Miguel McDonald Junior, Ay

Andrea Mejia Sophomore, Ph/Ay

Celina Mikolajczak Junior, EAS

Alfredo Morales Sophomore, Physics

Aris Moustakas Senior, Physics Richter SURF

Asim Mughal Senior, EE

Ashoke Mukherji Junior, Economics

Chris Myers Junior, EE/History Richter SURF

Johnny Ng Senior, CS Richter SURF

Kent Nordstrom Senior, APh Donald S. Clark SURF

Topic

Compact Optical Diode

Smoke-Wire Visualization of Air Entrainment in a Laminar Diffusion Flame

Phase Functions for NTrZ, NTeZ, NEB, and SEB Derived from Voyager High- and Low-Phase Angle Observations: Are Zones Really Belts in Sheep's Clothing?

Applications of UV astronomy

Exploding Stars, Forest Fires, and Close Encounters

Exploding Stars, Forest Fires, and Close Encounters

Honeybees' Response to Alternating Magnetic Fields

Study of Interface Separating Superfluid and Normal Liquid ⁴He Phases in the Presence of a Uniform Gravitational Field

Microwave Microwatt Interferometry and Telemetry Experimental Satellite (µMITES)

An Analysis of Aid to Families With Dependent Children Fraud

The Male Life in Rural Liaoning, 1774-1873

Hebbian Learning in a Computer Vision System

Carrier Lifetimes in Al_{*}GA1-*As

Sponsor

H. Jeffrey Kimble Professor of Physics

Edward E. Zukoski Professor of Jet Propulsion and Mechanical Engineering

Kevin H. Baines Member of the Technical Staff, JPL

Arthur L. Lane Section Manager, Geology and Planetology, JPL

Eleanor F. Helin Planetary Astronomer, Planetology and Oceanography, JPL

Eleanor F. Helin Planetary Astronomer, Planetology and Oceanography, JPL

Joseph L. Kirschvink Associate Professor of Geobiology

Peter B. Weichman Weingart Fellow in Theoretical Physics

Robert C. Clauss Systems Development Program Manager, TDA Office, JPL Edward C. Posner Visiting Professor of Electrical Engineering

Louis L. Wilde Professor of Economics

James Z. Lee Associate Professor of History

Daniel M. Kammen Chaim Weizmann Postdoctoral Fellow in Computation and Neural Systems

Amnon Yariv V Thomas G. Myers Professor of Electrical Engineering and Professor of Applied Physics

David Norris Junior, Chemistry University of Chicago NSF SURF

Jay Obernolte Sophomore, CS NSF SURF

Christopher Oei Senior, Physics

Louise Perry Senior, AMa University of California at Los Angeles

Alan Perzigian Senior, Aeronautical and Astronautical Engineering Massachusetts Institute of Technology

Bao Quoc Pham Junior, Physics

Christopher Pluhar Senior, GPS

Andrew Poulsen Junior, ME Massachusetts Institute of Technology

Betty Pun Sophomore, ChE NSF SURF

N. Scott Rafer Senior, Management and Technology University of Pennsylvania

Faress Rahman Senior, EAS/ME Lang SURF

Chandra Raman Senior, EE/AMa Richter SURF

Topic

Catalytic Studies with Parahydrogen Enhanced NMR Sensitivity

Sow Bug Simulation

Design and Implementation of a New Algorithm for Forward and Inverse Kinematics

Spacecraft Constraint Checking on the Hypercube Concurrent Processor

PSR Actuation System Development

Potts Cluster Demonstration Program

Magnetostratigraphy of Plio-Pleistocene Lake Manix Sediments

Optical Interferometer Enhancement

Stable Protein in Non-Aqueous Solvents

Plan for Task Scheduling and Allocation

Fluid Forces on Turbo Machinery

Electrical Technology in Rural Areas of India

Sponsor

Daniel P. Weitekamp Assistant Professor of Chemistry

Jerome Pine Professor of Physics

John Beahan Member of the Technical Staff, Tele/Autonomous Systems, JPL

Joan C. Horvath Magellan Sequence Design Engineer, JPL

Michael L. Agronin Member of the Technical Staff, JPL

Clive F. Baillie Staff Scientist

Joseph L. Kirschvink Associate Professor of Geobiology

Mike Shao Group Supervisor, Spatial Interferometry, JPL

Frances H. Arnold Assistant Professor of Chemical Engineering

William Whitney Division Technologist, JPL Martin Leipold Member of Technical Staff, JPL

Christopher E. Brennen Professor of Mechanical Engineering

Jeffrey A. Dubin Associate Professor of Economics Thayer Scudder Professor of Anthropology

Carlos Ramirez Junior, APh

Mary Katherine Raymond Junior, Ch Reed College NSF SURF

Roland Rocafort Senior, ME Massachusetts Institute of Technology

Frederick Roeber Senior, Ph Richter SURF

William Rogers Sophomore, EE AMETEK SURF

Steven Rosenberg Senior, Ma Richter SURF

Erik Russell Junior, GePh/Bi

Behnam Sadeghi Junior, Ma Occidental College

Pongskorn Saipetch Junior, Ph

Michael Samoilov Junior, Ma Richter SURF

M. Alex Santoso Senior, EAS

Topic

The Use of Individualized Compensation Filters to Improve Reading Speed in Observers with Losses in Central Vision

A Study of Urea Using NMR Spectroscopy

A Single Axis Teleoperator System

The Design of the L3 BGO EM Calorimeter RFQ Calibration System High Energy Beam Transport and Focusing System and Gas Cell Neutralizer

Passive Autofocus and Ranging for Artificial Retinas

Problems in Combinatorial Graph Theory

Infrared Mapping of the Jovian Stratosphere

Engine Simulation

BaF2 Scintillator and Light Readout System

Derivation of Some Central Theories of Topology

Applications of UV Astronomy

Sponsor

Teri A. Lawton Member of the Technical Staff, JPL

John D. Roberts // Institute Professor of Chemistry, Emeritus

Blake Hannaford Group Supervisor, Man-Machine Systems, JPL

Harvey B. Newman Associate Professor of Physics

Christof Koch Assistant Professor of Computation and Neural Systems

Richard M. Wilson Professor of Mathematics

Glenn S. Orton Member of the Technical Staff, JPL

Jonas S. Zmuidzinas Member of the Technical Staff, Space Physics and Astrophysics, JPL

Harvey B. Newman Associate Professor of Physics

David Gabai Professor of Mathematics

Arthur L. Lane Section Manager, Geology and Planetology, JPL

Zulfiquar Sayeed Senior, EE

Erich Schneider Junior, CS

Dylan SeLegue Junior, Ma Richter SURF

Derek Slye Senior, EAS GM SURF

S. Lan Smith Sophomore, ChE NSF SURF

Mike Smyth Senior, Ph

Craig Sosin Senior, Ph

Merion Stewart Senior, Bi Morehouse College

Barry Stipe Junior, Ph Lester Lees SURF

Pei-hsiu Suen Senior, EE

Atul Suklikar Junior, EE NSF SURF

Blake Sullivan Senior, EAS

Catherine Swift Senior, Ge

Topic

Estimation of rms Phase Error in Phase Locked Loop to be Used in Deep Space Optical Communication

An Application of Case Grammar to a Computational Linguistic System

Genus G Systems and the Mathieu Groups

Optical Investigation of the Geometry of Supersonic Shear Layer Instabilities

Magnetic Resonance Imaging of Colloidal Brain Cysts

Tools for the Analysis of Muon Time Series

Modelling of the H2 Ultraviolet Emission Spectrum

Molecular Biology of Human Potassium Ion Channels

Studies of Shock Focusing for Extracorporeal Shock Wave

Investigations of the Effects of Damping Circuitry on the Stability of the Cuk Converter

The Scope of the Telephone-Computer and Such Advanced Communication Systems in the Development of Pakistan & India

Applications of UV Astronomy

Ground-based CCD Imaging of Neptune in 1989

Sponsor

James R. Lesh Supervisor, Optical Communications, JPL

Bozena H. Thompson Senior Research Associate in Linguistics and Lecturer in Linguistics

Michael Aschbacher Professor of Mathematics

Paul E. Dimotakis Professor of Aeronautics and Applied Physics

John D. Roberts Institute Professor of Chemistry, Emeritus

Barry C. Barish Professor of Physics

Ewine van Dishoeck Assistant Professor of Cosmochemistry and Planetary Science

Mark Tanouye Assistant Professor of Biology

Bradford Sturtevant V Professor of Aeronautics

Slobodan M. Cuk Associate Professor of Electrical Engineering

Frederick B. Thompson Professor of Applied Philosophy and Computer Science

Arthur L. Lane Section Manager, Geology and Planetology, JPL

Kevin H. Baines Member of the Technical Staff, JPL Heidi Hammel National Research Council Resident Research Associate, JPL

Tannishtha Junior, Bi Williams College NSF SURF

Ross TenEyck Senior, ME/Lit Richter SURF

Glenn Tesler Senior, Ma/Ph Richter SURF

Carol Thompson Senior, Ma Fresno Pacific College

David Townsend Senior, Ph

Chandra Tucker Junior, Bi Bristol-Myers SURF

Christopher Tully Sophomore, Ph

Kevin Van Bladel Senior, Ph Krown SURF

Bonnie Wallace Sophomore, Ay

Elizabeth Warner Junior, Ch/EAS Adams SURF

Leon Waxer Senior, Ph Colorado College NSF SURF

Topic

Crystallization of Proteins for X-ray Crystallography

Self-Controlled Walking Machine

Packings and Coverings in Graded Posets

Caseload of the Coroner's Office to the Year 2000

Applications of UV Astronomy

Characterization of IL2-CAT Transgenic Mice

The Energy Resolution for Reconstructed Photons and Leptons in the L3 Detector

Scintillation Liquids for a Neutrino Oscillation Detector

Asteroid Photometry: Photoelectric Measurement of 1036 Ganymed

Studies in Biomimetic Molecular Recognition

High Resolution Optical Parametric Oscillator for High Resolution Spectroscopy of Ions and Clusters

Sponsor

Pamela Bjorkman Assistant Professor of Biology

Joel W. Burdick Assistant Professor of Mechanical Engineering

Richard M. Wilson Professor of Mathematics

Jeffrey A. Dubin Associate Professor of Economics Michael Udell Graduate Student J. Lawrence Cogan, M.D. Forensic Medicine Division, Department of Chief Medical Examiner-Coroner, Los Angeles County

Arthur L. Lane Section Manager, Geology and Planetology, JPL

Ellen Rothenberg Associate Professor of Biology Julia Yang Graduate Student

Harvey B. Newman Associate Professor of Physics

Felix H. Boehm William L. Valentine Professor of Physics

Alan W. Harris Supervisor, Earth and Planetary Physics, JPL

Dennis A. Dougherty Associate Professor of Chemistry

Mitchio Okumura Assistant Professor of Chemical Physics

Alex Wein Junior, Ch/H Colvin SURF

Adam Weissman Senior, Ph

Emily Wen Sophomore, ChE

John Wendel Junior, Ch Lindstrom SURF

John Werner Senior, Ge

Tracy Wilson Senior, Ch Spelman College

Scot Wolfe Senior, Bi/Ch Arthur A. Noyes SURF

Ki-Ching Wong Senior, Ph

Peyjen Wu Junior, EE NSF SURF

Su-Lin Wu Junior, EE AMETEK SURF

Xiaojian Yan Senior, Ph Richter SURF

Jack Yeh Sophomore, Ch Brown University

Richard Yeh Senior, EE/Ec Pacific Telesis SURF

Topic

Use of Angular Correlation of Radioactivity in Order to Determine Effective Drug Delivery of Reconstituted Viruses in Mice

Applications of UV Astronomy

Immobilized Metal Affinity Separations of Proteins

Synthesis and Cyclization Studies of a Biradical Precursor

Solar Energy Deposition in the Uranian Atmosphere

Characterization of Genes Expressing Inflorescence in Arabidopsis Thaliana

Charge-Charge Interactions in Binding and Catalysis by Enzymes: The Role of Lysine-234 in RTEM-1 Beta-lactamase

A Study of the Scintillation Tank's Optics in the Macro Detector

Putting Theories Back on Course: Implementation of the Neural Net Based Speech Recognizer

Rendering of Polygons in Three Dimensions Using Multicomputers and a Distributed Database

Precise Calibration of CaF2 Target for Superconducting Supercollider

Determination of N2 Spectral Line Parameters from Infra-red Solar Absorption Spectra

Experimental Projects in Control Theory

Sponsor

John D. Baldeschwieler Professor of Chemistry

Arthur L. Lane Section Manager, Geology and Planetology, JPL

Frances H. Arnold Assistant Professor of Chemical Engineering

Andrew G. Myers Assistant Professor of Chemistry

Kevin H. Baines Member of the Technical Staff, JPL

Elliot Meyerowitz Associate Professor of Biology John Bowman Graduate Student

John H. Richards Professor of Organic Chemistry

Barry C. Barish Professor of Physics

John J. Hopfield Roscoe G. Dickinson Professor of Chemistry and Biology Douglas A. Kerns Graduate Student

Charles L. Seitz Professor of Computer Science

Harvey B. Newman Associate Professor of Physics

Linda R. Brown Michael R. Gunson Members of the Technical Staff, JPL

John C. Doyle Associate Professor of Electrical Engineering

Topic

Linda Ying Sophomore, EE/CS

Xiaolei Zhu Senior, AMa

Chris Ziomkowski Sophomore, CNS NSF SURF Project SEED

The Building of a Fourier Transform Ultraviolet Spectrometer

Neural Response in Tiger Salamander Retina

Sponsor

James M. Bower Assistant Professor of Biology

Yuk L. Yung Professor of Planetary Science

Jerome Pine Professor of Physics

Aeronautics Ae AMa Applied Math APh Applied Physics Ay Astronomy Bi Biology Ch Chemistry ChE Chemical Engineering CNS Computation and Neural Systems CS Computer Science EE **Electrical Engineering** Ec **Economics** Eng Engineering Ge Geology GePh Geophysics Hist · History Lit Literature Ma Mathematics ME Mechanical Engineering Ph Physics SS Social Sciences

1989 SURF Donors

Donors to SURF have been strong believers in individual endowment funds that will ensure funding for SURF in perpetuity. A gift of \$50,000 or more will establish a SURF Endowment Fund, the earnings from which will provide support for one SURFer per year. This endowment fund may be named as the donor designates and may be made by bequest. Of course, we can provide for a SURF fellowship each year through a \$3000 annual contribution. The SURF program may also be named as the recipient of the remainder of a Caltech trust or annuity plan.

SURF Endowments

Arthur R. Adams SURF Fellowships Bristol-Myers Endowment Fellowship Class of '36 Endowment Fund Hugh F. and Audy Lou Colvin SURF Endowment Fellowship Hugh F. and Audy Lou Colvin International Fellowship Endowment Flintridge Foundation SURF Samuel P. and Frances Krown Endowment Fund William H. and Helen Lang SURF Endowment Fund Lester Lees Aeronautics SURF Fellowship Peter A. Lindstrom SURF Endowment Northern California Associates SURF Endowment Fund Donald S. Clark SURF Endowment Fund William N. Lacey SURF Endowment Fund Thomas Hunt Morgan SURF Endowment Fund Arthur A. Noyes SURF Endowment Fund Ernest H. Swift SURF Endowment Fund Professor Fredrick H. Shair SURF Endowment

Corporate and Foundation Donors

The Caltech Alumni Association AMETEK, Inc. Bristol-Myers Company Ford Motor Company General Motors Corporation Los Angeles Times, Inc. National Science Foundation Pacific Telesis Group Paul K. and Evalyn Elizabeth Cook Richter Memorial Fund

Matching funds were received from the following corporations: Allied-Signal, Inc. BASF Corporation TRW Inc.

Individual Donors

Mr. and Mrs. Paul H. Allen Mr. Robert M. Abbey Mr. Arthur R. Adams Mr. and Mrs. Paul L. Armstrong, Jr. Mrs. Vernon Barrett Dr. W. Wilhelm Beherns Mr. Joel and Dr. Marcella Bonsall Dr. and Mrs. Thomas J. Buckholtz Mr. Richard J. Burke Mr. and Mrs. Richard K. Cardwell Mr. John C. Carney Dr. Donald J. Collins Mr. and Mrs. Hugh F. Colvin Mr. Phillip G. Cook Mr. and Mrs. Frederick W. Drury, Jr. Dr. and Mrs. Hubert E. Dubb Mr. Joseph B. Earl Mr. Orrin K. Earl Mrs. John H. Emerson Mr. and Mrs. Clayton H. Englar Dr. and Mrs. Thomas E. Everhart Dr. and Mrs. Robert B. Freeman Mr. and Mrs. William N. Harris Mr. Robert T. Herzog Mr. and Mrs. Robert E. Hunter Mr. and Mrs. Theodore P. Hurwitz Dr. and Mrs. W. Barclay Kamb Dr. James M. Kendall, Jr. Dr. and Mrs. Robert M. Kieckhefer Mr. and Mrs. Samuel P. Krown Mr. and Mrs. Carl V. Larson

Mr. William H. Lang Mrs. Lester Lees Dr. Jack E. Leonard Mr. Howard W. Lindstrom Mr. and Mrs. Fred W. Morris Mr. and Mrs. Downey D. Muir, III Dr. Andrew G. Myers Mr. and Mrs. John B. Nelson Mr. and Mrs. Douglas B. Nickerson Dr. Mitchio Okumura Mr. and Mrs. Robert C. Perpall Dr. and Mrs. George T. Preston Dr. Eli Reshotko Mrs. Jack H. Samson Dr. and Mrs. William P. Schaefer Dr. and Mrs. Warren G. Schlinger Mr. and Mrs. Curt D. Schulze Mr. Loyd C. Sigmon Mr. and Mrs. H. Russell Smith Mr. and Mrs. Rodney B. Spears Mr. and Mrs. Thomas A. Tisch

If you would like further information about how you can contribute to SURF, please contact:

Christine Kozojet SURF Liaison California Institute of Technology Development Office 105–40 Pasadena, California 91125 (818) 356–6286

SURF Administrative Committee

Terry Cole, Chairman Frances H. Arnold Christopher E. Brennen* Charles J. Brokaw Glen R. Cass J. Thomas Gelder* Robert H. Grubbs Herbert B. Keller Joseph L. Kirschvink James Z. Lee David S. Levv* Kenneth G. Libbrecht Carolyn A. Merkel* Georgia A. Morton* Thomas A. Prince Mark A. Tanouye Thomas A. Tombrello Louis L. Wilde* Richard M. Wilson * Ex Officio

Christine Kozojet*

E.C. Posner IV M Whitney

SURF Board

Hugh F. Colvin, Chairman Arthur R. Adams, Vice Chairman AMETEK, Inc., Alfred Schaff Marcella R. Bonsall Hannah G. Bradley Calreco, Inc., Joseph F. Cullen Theodore C. Coleman The O.K. Earl Corporation, Joseph B. Earl Flintridge Foundation, Jaylene L. Moseley Ford Motor Company, Norman A. Gjostein General Motors Corporation, Jeffrey A. Sell William N. Harris IBM Corporation, Paul Y. Hu Joanna W. Muir Douglas B. Nickerson Robert L. Shafer Loyd C. Sigmon TRW Inc., Lindsey Lindemann

Life Members

Lee A. DuBridge Samuel P. Krown Hans W. Liepmann Elizabeth G. Nickerson Ray D. Owen Robert P. Sharp





SURF Office California Institute of Technology Room 3 Dabney, Mail Code 6–40 Pasadena, California 91125 (818) 356–3675